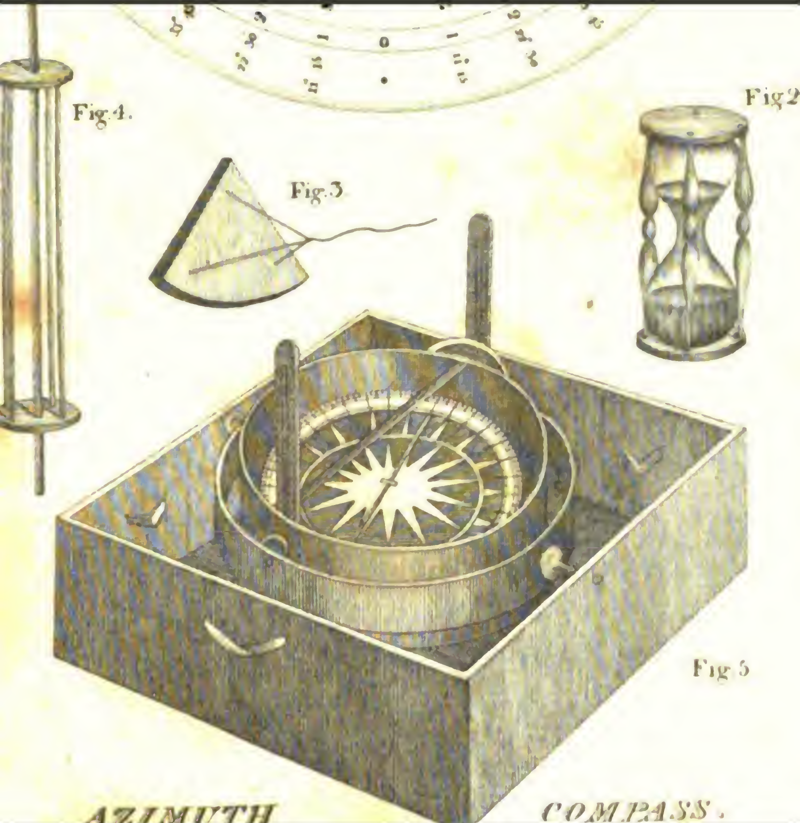

The new American practical navigator

Nathaniel Bowditch

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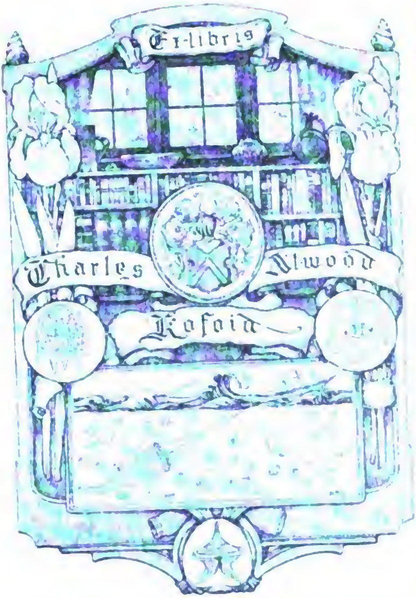
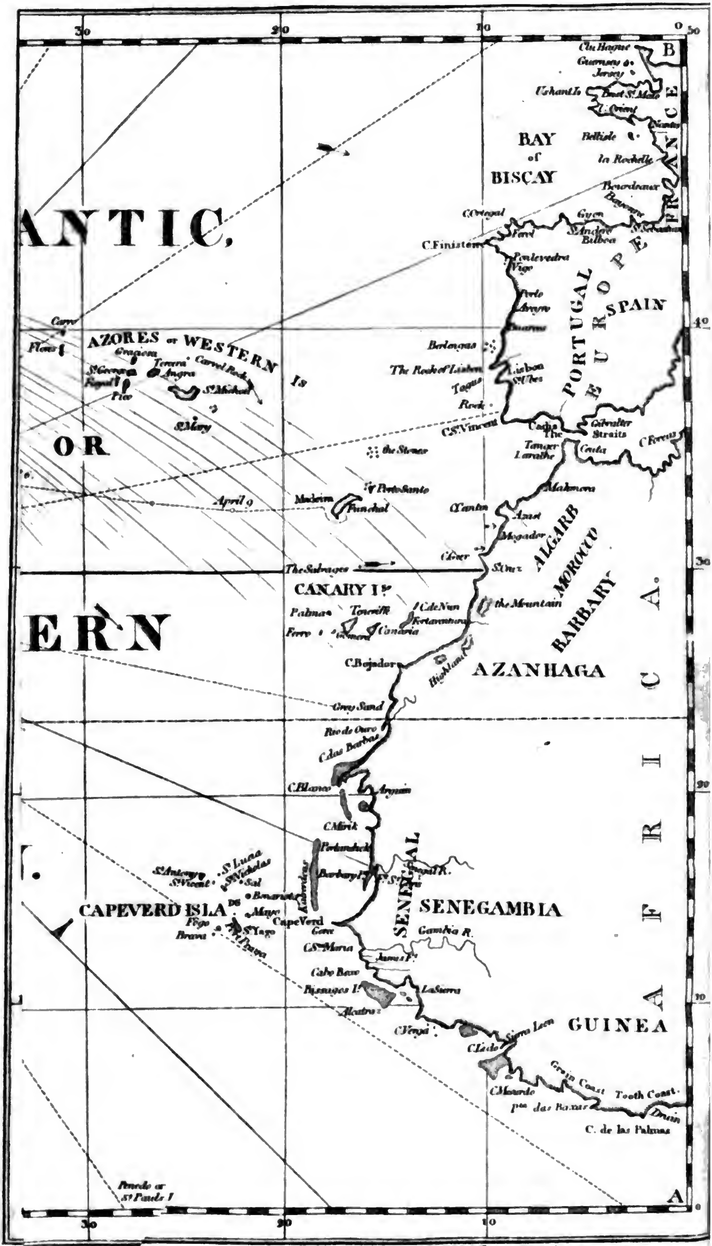


Edward R. Price, April 26th 1827

Davis Goodbread
1908



WILLIAM HOOKER, No 202 Water Street NEW-YORK

THE NEW AMERICAN PRACTICAL NAVIGATOR:

BEING AN

EPITOME OF NAVIGATION;

CONTAINING ALL THE TABLES NECESSARY TO BE SED WITH THE

NAUTICAL ALMANAC,

IN DETERMINING

THE LATITUDE, AND THE LONGITUDE

BY

LUNAR OBSERVATIONS:

AND

KEEPING A COMPLETE RECKONING AT SEA:

ILLUSTRATED BY

PROPER RULES AND EXAMPLES:

THE WHOLE EXEMPLIFIED IN A JOURNAL,

KEPT FROM BOSTON TO MADEIRA,

IN WHICH ALL THE RULES OF NAVIGATION ARE INTRODUCED.

ALSO,

THE DEMONSTRATION OF THE USUAL RULES OF TRIGONOMETRY:

PROBLEMS

IN MENSURATION, SURVEYING AND GAUGING:

DICTIONARY OF SEA-TERMS:

AND THE MANNER OF

PERFORMING THE MOST USEFUL EVOLUTIONS AT SEA.

WITH AN

APPENDIX,

CONTAINING

METHODS OF CALCULATING ECLIPSES OF THE SUN AND MOON, AND OCCULTATIONS OF THE FIXED STARS: RULES FOR FINDING THE LONGITUDE OF A PLACE BY OBSERVATIONS OF ECLIPSES OR OCCULTATIONS: AND A NEW METHOD FOR FINDING THE LATITUDE BY TWO ALTITUDES.

BY NATHANIEL BOWDITCH, LL. D.

Fellow of the Royal Societies of London, Edinburgh, and Dublin; of the American Philosophical Society, held at Philadelphia: of the American Academy of Arts and Sciences; of the Connecticut Academy of Arts and Sciences; of the Literary and Philosophical Society of New-York, &c.

SIXTH STEREOTYPE EDITION.

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Sci Travel

REPORT

Of the Committee, appointed by the East India Marine Society *of Salem, at their meeting on the 6th of May,* 1801, *to examine a work called "The New American Practical Navigator, by Nathaniel Bowditch, F. A. A."*

AFTER a full examination of the system of Navigation presented to the society by one of its members (Mr. Nathaniel Bowditch) they find, that he has corrected many thousand errors existing in the best European works of the kind; especially those in the Tables for determining the latitude by two altitudes, in those of difference of latitude and departure, of the sun's right ascension, of amplitudes, and many others necessary to the Navigator. Mr. Bowditch has likewise, in many instances, greatly improved the old methods of calculation, and added new ones of his own. That of clearing the apparent distance of the moon, and sun or stars, from the effect of parallax and refraction, is peculiarly adapted to the use of seamen in general, and is much facilitated (as all other methods are) in the present work, by the introduction of a proportional table into that of the correction of the moon's altitude. His Table nineteenth, [the twentieth of the present edition] of corrections to be applied in the lunar calculations, has the merit of being the only accurate one the Committee are acquainted with. He has much improved the table of latitudes and longitudes of places, and has added those of a number on the American coast, hitherto very inaccurately ascertained.

This work, therefore, is, in the opinion of the Committee, highly deserving of the approbation and encouragement of the society, not only as being the most correct and ample now extant, but as being a genuine American production; and as such they hesitate not to recommend it to the attention of Navigators, and to the public at large.

JONATHAN LAMBERT,
BENJAMIN CARPENTER,
JOHN OSGOOD,
JOHN GIBAUT,
JACOB CROWNINSHIELD,
} *Committee.*

Approved. BENJAMIN HODGES, *President.*

A true copy. MOSES TOWNSEND, *Sec'ry.*

Salem, May 13, 1801.

PREFACE.

IN the preface to the first edition of this work, it was observed, that the object of the publication was to collect into one volume all the rules, examples and tables necessary for forming a complete system of *practical* navigation. To do this, those authors were consulted whose writings afforded the best materials for the purpose,* and such additions and improvements were introduced as were suggested by a close attention to the subject; and the accuracy of the tables accompanying the work was ensured by actually going through all the calculations necessary to a complete examination of them, making the last figure exact to the nearest unit. In performing this, above eight thousand errors were discovered and corrected in Moore's Practical Navigator, and above two thousand in the second edition of Maskelyne's Requisite Tables.† Almost all the errors in Maskelyne's collection were in the last decimal place, and in most cases would but little affect the result of any *nautical* calculation; but when it is considered that most of those tables are useful in *other* calculations, where great accuracy is required, it will not be deemed an unnecessary improvement to have corrected so great a number of small errors.

Several articles were added in the second edition, particularly the description and use of the circular instrument of reflection, methods of surveying harbours, new tables, &c. In the third and subsequent editions, several improvements have been made, particularly in the method of correcting the dead reckoning, and in the articles of surveying. An Appendix is given, containing methods of projecting and calculating eclipses of the moon and sun, and occultations of the fixed stars or planets by the moon; rules for deducing the longitude of a place from observations of eclipses of the sun or occultations; a new and short method of calculating the altitude and longitude of the nonagesimal degree of the ecliptic; solutions of several useful problems of Nautical Astronomy, and an improvement of Napier's rules for the solution of spheric triangles. Several new tables were added. The table of latitudes and longitudes is much increased and corrected.

Also an entirely new article is given in this edition on the method of finding the latitudes by two altitudes of the same, or of different objects: the solutions being direct and simple, embracing all the cases of the problem: a point which has not been attended to in some works of celebrity. This is an important addition to the present work, and it is recommended to the consideration of navigators.

The tables published separately in the Appendix of the first edition are introduced into the body of this work, and are extended so as to render the use of them more simple. The short and easy method of working a lunar observation, published in that Appendix, which has one great advantage over all other approximate methods, in the manner of applying the corrections (all them being additive) is here explained and illustrated by several examples.‡ Two other methods of correcting the apparent distance are given; one being that invented by the author of this work in the year 1795;

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* The works chiefly consulted were those published by Maskelyne, Roberston, Patoun, Rios, &c. and a treatise on "Seamanship," published at London in 1795. In this new edition, the work of the Chevalier de Borda, entitled "Description et Usage du Cercle de Reflection," &c. has also been used.

† In the third edition of that work the errors of the table of proportional logarithms are corrected.

‡ This method was communicated to Mr. De Lambre, who published an account of it in the "Connoissance des temps pour l'annee, 1808."

the other an improvement of Witchell's method, in which, without altering materially the calculation, the number of cases is considerably reduced.

To promote the accuracy of the successive editions of this work, all the tables (which admit of it) have been stereotyped, namely, Tables I. II. III. V. VII. IX. X. XI. XII. XIII. XIV. XV. XVI. XVII. XVIII. XIX. XX. XXI. XXII. XXIII. XXIV. XXV. XXVI. XXVII. XXVIII. XXIX. XXX. XXXI. XXXII. XXXIII. XXXIV. XXXV. XXXVI. XXXVIII. XXXIX. XL. XLI. XLII. XLIII. XLIV. and XLV. Since the publication of the first stereotype edition, these Tables have been carefully examined by the author, and the few mistakes which were discovered, have been corrected in the plates.

Any person who wishes to examine the tables, may do it by the methods used for that purpose, which will here be explained with some additional remarks.

Tables I. and II. were calculated by the natural sines taken from the fourth edition of Sherwin's logarithms, which were previously examined, by differences; when the proof-sheets of the first edition were examined, the numbers were again calculated by the natural sines in the second edition of Hutton's logarithms; and if any difference was found, the numbers were calculated a third time by Taylor's logarithms.

Table III. contains the meridional parts for every degree and minute of the quadrant, calculated by the following rule, viz.

$$M = T \times 0.0007915704468.$$

in which T is the log-tangent less radius of half the latitude increased by 45° taken to seven places of figures, reckoned as integers, and M is the meridional parts of that latitude in miles.

Table IV. contains the declination of the sun, which was compared with the Nautical Almanacs for the years 1824, 1825, 1826, and 1827, and marked to the nearest minute.

Table IV. A. The Equation of Time, for the years 1824, 1825, 1826, and 1827.

Table V. contains the correction of the sun's declination, as published by Dr. Maskelyne. The correction taken from this table will rarely differ more than 16 or 17 seconds from the truth.

Table VI. contains the mean of the sun's right ascension, taken from the Nautical Almanacs for the years 1824, 1825, 1826, and 1827.

Table VI. A. contains the correction for the daily variation of the Equation of Time.

Table VII. contains the amplitudes of the sun for various latitudes and declinations calculated by Taylor's logarithms by this rule:

Log. sec. lat. + Log. sine declination—10.0000000 = Log. sine amplitude.

Table VIII. contains the right ascensions and declinations of 76 stars of the first and second magnitudes, with their annual variations, adapted to the beginning of the year 1820. This table was formed from that published by the Astronomer Royal at Greenwich (Mr. Pond) in the Nautical Almanac for 1823, with the addition of a number of stars from the Catalogue of Baron Von Zach.

Table IX. contains the time of the sun's rising and setting, calculated by Taylor's logarithms by this rule:

Log. cos. hour = Log. tang. declin. + Log. tang. latitude—10.0000000.

Table X. contains the distances at which any object is visible at sea, calculated by the rule given in § 195 of Vince's Astronomy, in which the terrestrial refraction was noticed: this circumstance was neglected by Robertson, Moore, and others, and of course their tables are erroneous. The rule given by Mr. Vince, expressed in logarithms, is this:

0.12155 + Half log. of height in feet = Log. of dist. in statute miles.

In reducing the rule to logarithms, the radius of the earth was called 20911790 feet, which agrees nearly with the mean value given in De La Lande's Astronomy.

Table XI. is a common table of proportional parts, the construction of which does not need any explanation.

TABLE XII. contains the refraction of the heavenly bodies, calculated by Dr. Bradley's rule, supposing the refraction to be as the tangent of the apparent zenith distance of the object decreased by three times the refraction, the horizontal refraction being supposed equal to 33′.

The rule expressed in logarithms is this :

Log. tang. (app. zen. dist.—3. refraction)—8.2438534=Log. of ref. in sec.

The numbers calculated by this rule agree nearly with those published in Table I. of Maskelyne's Requisite Tables.

TABLE XIII. contains the dip of the horizon for various heights, calculated by the rule in § 197 of Vince's Astronomy, in which the terrestrial refraction is allowed for. All the numbers of this table differ a little from those published by Dr. Maskelyne, who had made a different allowance for that refraction. The rule given by Mr. Vince, expressed in logarithms, is: 1.7712711+half the log. of the height in feet=Log. dip in seconds.

TABLE XIV. contains the sun's parallax in altitude, calculated by multiplying the natural sine of the apparent zenith distance by the sun's horizontal parallax 8¾″. The numbers in this table agree with those published by Dr. Maskelyne.

Table XV. contains the augmentation of the moon's semi-diameter= 15″. 626 × sine ☽ 's altitude. This table agrees nearly with that published by Maskelyne.

TABLE XVI. contains the dip for various distances and heights, calculated by this rule.

$$D=\frac{3}{7}d+0.56514\times\frac{h}{d}$$

in which D represents the dip in miles or minutes, d the distance of the land in sea miles, and h the height of the eye of the observer in feet.

TABLES XVII. XVIII. and XIX. were first calculated by the author of this work, and published in the Appendix to the first edition. The correction in the first of these tables is equal to the difference between the star's refraction and 60′. The correction of Table XVIII. is equal to the difference between 60′ and the correction of the sun's altitude for parallax and refraction. The correction of Table XIX. is equal to the difference between 59′ 42″ and the correction of the moon's altitude for parallax and refraction. The logarithms in each of these tables may be found by adding together the constant log. 9.6990, the log. co-sine of the apparent altitude of the object, the proportional logarithm of the correction of the altitude of the object for parallax and refraction, and rejecting 20 from the index. The method of performing these calculations are so obvious, that it is unnecessary to enter into any farther explanation. Most of the numbers in these tables were calculated three different times.

TABLE XX. There are two columns in this table corresponding to each degree, the numbers in one column exceed those of the other by 18″, the numbers in the least column express the difference b, between the base B and the hypotenuse B$\pm b$ of a right angled spheric triangle, whose third side P, never exceeds 60′; the argument at the top of the table being B, and at the side 60′$\pm$P. The value of b being found by this rule by Taylor's logarithms :

$$\text{Log. } b \text{ in seconds} = \text{Log. co-tang. B} + \text{Log. vers. sine P} - 14.6855749 - \text{Diff.} \frac{}{\text{log. sines of B and B} \pm \tfrac{1}{2}b}$$

in which the last term may in most cases be neglected.

TABLE XX. (New Form.) corrections in seconds *additive*. See appendix, page 618.

TABLE XXI. for turning time into degrees, is the same as in other works of this kind.

TABLE XXII. contains the proportional logarithms for three hours. The numbers of this table may be found by subtracting the logarithm of the time in seconds from the log. of 10300″ ; or, which is the same thing, by the following rule :

Prop. log. T=4.0334738—log. of T in seconds, neglecting the three right hand figures of the remainder.

TABLE XXIII. was first constructed by Mr. Douwes of Amsterdam, about the year 1740, for which he received £.50 of the Commissioners of Longitude in England. This table was published in the first and second editions of the Requisite Tables; in the former of which it was carried as far as six hours; in the latter the table of Log. Rising was extended to 9 hours; in the present edition of this work it is extended to 12 hours. The numbers in this table are easily deduced from the log. sines, log. co-secants, and log. versed sines of the hour to which they correspond. Thus, if the time, opposite to any number of these tables turned into degrees, is H, we shall have

$$\text{Log. } \tfrac{1}{2} \text{ elapsed time of } H = \text{log. co-secant } H - 10.0000000$$
$$\text{Log. middle time } = \text{Log. sine } H - 4.6989700$$
$$\text{Log. rising } H \begin{cases} = \text{Log. versed sine } H - 5.0000000 \\ = 2 \times \text{ log. sine } \tfrac{1}{2} H - 14.6989700 \end{cases}$$

By means of these formulæ, the numbers of Table XXIII. were calculated by Sherwin's, Hutton's and Taylor's logarithms, and above a thousand errors were discovered in the second edition of the Requisite Tables, most of which were in the additional three hours (from six to nine hours) not published in the first edition. About two thirds of these additional numbers differ from their true values by one or two units.

TABLE XXIV. was compared with Sherwin's and Hutton's Tables, and a few errors corrected.

TABLE XXV. contains the log. sines, log. tangents, &c. corresponding to points and quarter points of the compass. This was compared with Sherwin's, Hutton's, and Taylor's logarithms.

TABLE XXVI. contains the common logarithms of numbers, which was compared with Sherwin's, Hutton's and Taylor's logarithms.

TABLE XXVII. contains the common log. sines, tangents, secants, &c. This was compared with Sherwin's, Hutton's and Taylor's tables. Two additional columns are given in this table, which are very convenient in finding the time from an altitude of the sun. The degrees are marked to 180°, which saves the trouble of subtracting the given angle from 180° when it exceeds 90°.

TABLE XXVIII. was calculated by proportioning the daily variation of the time of the moon's passing the meridian.

TABLE XXIX. contains the correction of the moon's altitude for parallax and refraction, corresponding to the parallax 57′ 30″.

TABLES XXX. and XXXI. are tables of proportional parts, taken from the Requisite Tables, with a few corrections.

TABLE XXXII. contains the variation of the altitude of any heavenly body for one minute of time from noon, for various degrees of latitude and declination. The following method was used in constructing the table:—A and B were calculated for each degree of declination by these formulæ.

$$\text{Log. } A = \text{Log. } 1''.96349 + 2 \text{ log. cos. declination} - 20.00000.$$
$$\text{Log. } B = \text{Log. } A. + \text{log. tang. declination} - 10.00000.$$

and then the correction of the table corresponding to the zenith distance Z ($=$Lat. $\underset{\backsim}{+}$ Dec.) was found by this formulæ. $A \times$ co-tang. $Z \pm B$. To facilitate the computation of these numbers, a table of the products of A by the whole numbers from 1 to 9 was calculated.

TABLE XXXIII. contains the squares of the minutes and parts of a minute corresponding to every second from 0″ to 12′ 59″. This requires no explanation.

TABLE XXXIV. contains the error of an observed angle arising from a deviation of 1′ in the parallelism of the surfaces of the central mirror, those surfaces being supposed to be perpendicular to the plane of the instrument. The correction in the fifth column of this table corresponding to any angle

A in the first column may be found nearly by Hutton's logarithms, as follows: to the constant logarithm 0.07345 add the log. secant of ½ A, find this in the column of log-tangents and take out the corresponding natural secant B, then the correction will be 2′(B—1,55.) The numbers in the second column are nearly equal to those in the fifth corresponding to the angle A + 20°, decreased by 1″.68. The numbers in the third column are equal to the difference between 1″.68, and the numbers in the fifth corresponding to $A \backsim 20^\circ$. The numbers in the fourth column are equal to the half difference of the numbers on the same horizontal line in columns second and third, when it exceeds 40°, otherwise their half sum.

TABLE XXXV. contains the correction to be applied to an observation taken in a direction inclined to the plane of the instrument. The following rule was used in calculating this table: Find an arch A such that

Log. sine A = Log. sine ½ observed angle + log. co-sine of error of inclination. Then the difference between 2 A and the observed angle will be the tabular correction.

TABLE XXXVI. contains the variation of the mean refraction (given in Table XII.) for various temperatures and densities of the air. The correction given in this Table is nearly the same as that deduced from Dr. Bradley's rule, which is as follows:—As the mean height of the barometer 29,6 inches is to the true height, so is the mean refraction to the corrected refraction; and as 350 increased by the height of Fahrenheit's thermometer is to 400, so is the corrected to the true refraction.

TABLE XXXVII. contains the latitudes and longitudes of the fixed stars of the 1st. 2d. and 3d. magnitudes. The nine stars, from which the distances are marked in the Nautical Almanac, are given from the table published in the Nautical Almanac for 1820. The rest were deduced from the table published in the second edition of Doctor Mackay's treatise on longitude, supposing the annual precession 50″.35 and the secular equation as in his table. In the third edition of his work, the precession was allowed on the latitude as well as the longitude, which causes an error of about 8′ in the latitudes of the stars in that edition.

TABLE XXXVIII. was calculated by this rule. Suppose L to be the latitude, R the reduction of latitude, then log. co-tang. (L—R) = 0.0029001 + log. co-tang. L. The reduction of parallax corresponding to 55′, 57′ and 61′, was found by these formulæs respectively 5″.3—5″.3 cos. 2 L; 5″.7—5″.7 cos. 2 L; 6″.1—6″.1 cos. 2 L.

TABLE XXXIX. was calculated by the rule in vol. I. page 334 of Vince's Astronomy, supposing S to be the place of the sun, P that of the planet, and T that of the earth.

Aberration $= -20''.\cos. STP - 20'' \sqrt{\frac{ST}{SP}}.\cos. SPT$. Making use of the distances, &c. given by La Place in vol. III. of his Mecanique Celeste. A small alteration was made in the rule in calculating the aberration of Mercury.

TABLE XL. was calculated by — 17″.9. sine long. ☽'s node.

TABLE XLI. was calculated by — 20″. cos. argument.

TABLE XLII. Part I. = —19″.173 cos. arg. Part II. = 0″.327 cos. arg.
Part III. = —3″.9314 cos. arg.

TABLE XLIII. Part I. = —8″.33 cos. arg. Part II. = —1″.22 cos. arg.
Part III. = —16″.382 sine arg.

TABLE XLIV. Part I. = 8″.1845 sine arg. Part II. $= \frac{(\text{arg. in seconds})^2}{960''}$

Part III. = 960″ × sine ☽'s par. in lat. × tang. ☽'s true lat.
—960. versed sine par. in lat.

If we suppose the sum of these three parts to be S seconds, and the moon's horizontal semi-diameter to be D minutes. Part IV. corresponding to S and D will be $S \times \frac{(D+16)(D-16)}{256}$

TABLE XLV. The arguments at the side being B and 12—B hours, and the second difference at the top A, the correction of this table will be $\frac{A \times B(12-B)}{288}$

TABLE XLVI. contains the Latitudes and Longitudes of the most remarkable ports, harbours, &c. in the world. Great alterations were made in this table in the fifth edition, particularly by the insertion of more than thirteen hundred additional places in the India Seas and in the Pacific Ocean, besides various corrections in other parts of the world, consulting the latest and best authorities. Several corrections and additions have also been made in the present edition.

TABLE XLVII. contains the times of high water on the full and change of the moon, with the vertical rise of the tide, at many ports, harbours, &c. in the world. This table (like the preceding) depending wholly on observations, is therefore liable to be erroneous, though great pains have been taken to make it as correct as possible.

TABLE XLVIII. (Appendix, pages 616 and 617) contains the variation of the altitude of an object arising from a change of 100 seconds in the declination.

Most of the tables of this collection have been republished in London in several editions of a work having the following title: "*The Improved Practical Navigator, originally written and calculated by* NATHANIEL BOWDITCH; *revised, recalculated, and newly arranged, by* THOMAS KIRBY." But a number of mistakes have been made in printing the Tables of Mr. Kirby's first edition, some of which have been taken notice of by Dr. Mackay, in the preface of his "Complete Navigator;" and as the manner in which those mistakes are mentioned might lead the reader to suppose that the same errors existed in the American Tables, it is thought proper explicitly to state, that *not one* of the "many errors and contradictions," Doctor Mackay has mentioned, is to be found therein.

It may be observed that the first method of working double altitudes, given in page 133. is an improvement of a method published by Mr. Ivory.

CONTENTS.

ARRANGEMENT OF THE TABLES.

SIGNS AND ABBREVIATIONS USED IN THIS WORK.

$+$ Is the sign of addition, and denotes that whatever number or quantity follows the sign, must be added to those that go before it, thus $9+8$ signifies that 8 is to be added to 9. Or $A+B$ implies that the quantities represented by A and B are to be added. The sign $+$ is called the *positive* sign.

$-$ The sign of subtraction; and denotes that the number following it must be subtracted from those going before it, thus $7-5$, signifies that 5 must be subtracted from 7. The sign $-$ is called the *negative* sign.

$\times$ Is the sign of multiplication, and shows that the numbers placed before and after it are to be multiplied, thus, 7×9 signifies 7 multiplied by 9, which makes 63; and $7\times8\times2$ signifies the continued product of 7 by 8 and by 2, which makes 112. Multiplication is also denoted by placing a point between the quantities to be multiplied; thus A.B signifies that A is to be multiplied by B.

$\div$ Is the sign of division, and signifies that the number that stands before it is to be divided by the number following it, as $72\div12$ shows that 72 is to be divided by 12. Division may also be denoted by placing two points between the numbers, thus, $72:12$ represents 72 divided by 12 or by placing the numbers thus, $\frac{72}{12}$ which signifies 72 divided by 12.

( ) or $\overline{\quad\quad}$. Either of these marks is used for connecting numbers together, thus, $\overline{3+4}\times6$, or $(3+4)\times6$, signifies that the sum of 3 and 4 is to be multiplied by 6.

$=$ Is the sign of equality, and shows that the numbers or quantities placed before it are equal to those following it: thus $8\times12=96$. Or 8 multiplied by 12 are equal to 96, and $\overline{7+2}\times4=36$.

$: :: :$ Is the sign of proportion, and is marked thus, $7:14::10:20$, that is, as 7 is to 14, so is 10 to 20. Or $A:B::C:D$, that is, as A is to B, so is C to D.

$^{\circ}$ Signifies degrees; thus, 45° represents 45 degrees.

$'$ Signifies minutes; thus, $24'$ or 24 minutes,

$''$ Signifies seconds; thus, $44''$, or 44 seconds.

$'''$ Signifies thirds or sixtieth parts of seconds; thus, $44'''$, or 44 thirds.

S. Signifies sine. N. S. Signifies Natural sine.

Sec. Signifies Secant.

Tan. Signifies Tangent.

Co-sine, Co-tangent, or Co-secant of an arch signifies the sine, tangent or secant of the complement of that arch respectively.

$\angle$ Signifies Angle; with an s at top Angles, $\angle^{s}$

$\wedge$d Angled,

$\triangle$ Signifies Triangle. $\triangle$'s Triangles.

$\square$ Signifies a square.

$\odot$ or $\odot$ the Sun. ○ or ☽ the Moon. ✱ a Star. L. L. Lower Limb. U. L. Upper Limb. N. L. Nearest Limb. S. D. Semi-diameter. P. L. Proportional Logarithm. N. A. Nautical Almanac. Z. D. Zenith Distance. D. R. Dead Reckoning.

DIRECTIONS FOR THE BINDER.

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DECIMAL ARITHMETIC.

MANY persons who have acquired considerable skill in common Arithmetic, are unacquainted with the method of calculating by decimals, which is of great use in Navigation; for which reason it was thought proper to prefix the following brief explanation.

Fractions or *Vulgar Fractions* are expressions for any assignable part of an unit; they are usually denoted by two numbers, placed the one above the other, with a line between them: thus, $\frac{1}{4}$ denotes the fraction one-fourth, or one part out of four of some whole quantity, considered as divisible into four equal parts. The lower number 4 is called the *denominator* of the fraction, showing into how many parts the whole or integer is divided; and the upper number 1, is called the *numerator*, and shows how many of those equal parts are contained in the fraction. And it is evident that if the numerator and denominator be varied in the same ratio, the value of the fraction will remain unaltered: thus if the numerator and denominator of the fraction $\frac{1}{4}$ be multiplied by 2, 3, or 4, &c. the fractions arising will be $\frac{2}{8}$, $\frac{3}{12}$, $\frac{4}{16}$, &c, which are evidently equal to $\frac{1}{4}$.

Decimal Fraction is a fraction whose denominator is always an unit with some number of ciphers annexed, the numerators of which may be any numbers whatever; as $\frac{2}{10}$, $\frac{2}{100}$, $\frac{15}{1000}$, &c. And as the denominator of a decimal is always one of the numbers 10, 100, 1000, &c. the inconvenience of writing these denominators may be avoided, by placing a point between the integral and the fractional part of the number; thus $\frac{3}{10}$ is written .3; and $\frac{14}{100}$ is written .14; the *mixed* number 3 $\frac{14}{100}$, consisting of whole numbers and fractional ones is written 3.14.

In setting down a decimal fraction, the numerator must consist of as many places as there are ciphers in the denominator; and if it has not so many figures the defect must be supplied by placing ciphers before them; thus, $\frac{16}{100}$, $=.16$, $\frac{16}{1000}=.016$, $\frac{16}{10000}=.0016$, &c. And as ciphers on the right hand side of integers increase their value in a tenfold proportion, as 2, 20, 200, &c. so when set on the left hand of decimal fractions, they decrease their value in a tenfold proportion, as 2, .02, .002, &c. but ciphers set on the right hand of these fractions make no alteration in their value, neither of increase or decrease; thus, .2 is the same as .20 or .200. The common arithmetical operations are performed the same way in decimals, as they are integers; regard being had only to the particular notation, to distinguish the integral from the fractional part of a sum.

ADDITION OF DECIMALS.

Addition of decimals is performed exactly like that of whole numbers, placing the numbers of the same denomination under each other, in which case the decimal separating points will range straight in one column.

EXAMPLES.

	Miles.	Feet.	Inches.
	26.7	1.26	272.3267
	32.15	2.31	.0134
	143.206	1.785	2.1576
	.003	2.0	31.4
Sum	202.059	7.355	305.8977

SUBTRACTION OF DECIMALS.

Subtraction of decimals is performed in the same manner as in whole numbers, by observing to set the figures of the same denomination and the separating points directly under each other.

EXAMPLES.

From 31.267	36.75	1.254	1364.2
Take 2.63	.026	.316	25.163
Diff. 28.637	36.724	.938	1339.037

MULTIPLICATION OF DECIMALS.

Multiply the numbers together the same as if they were whole numbers, and point off as many decimals from the right hand as there are decimals in both factors together; and when it happens that there are not so many figures in the product as there must be decimals, then prefix as many ciphers to the left hand as will supply the defect.

EXAMPLE I.

Multiply 3.25 by 4.5

```
   3.25
   4.5
  ------
  1.625
  13.00
  ------
Answer 14.625
```

In one of the factors is one decimal and in the other two, their sum 3 is the number of decimals of the product.

EXAMPLE II.

Multiply 0.5 by 0.7

```
0.5
0.7
----
0.35 Answer.
```

EXAMPLE III.

Multiply 3.25 by .05

```
  3.25
   .05
  -----
 .1625 Product.
```

EXAMPLE IV. Multiply .17 by .06

```
       .17
       .06
       ----
Answer .0102
```

In each of the factors are two decimals, the product ought therefore to contain 4, and there being only three figures in the product I prefix a cipher.

EXAMPLE V. Multiply .18 by 24.

```
       .18
        24
       ----
        72
       36
       ----
Answer 4.32
```

EXAMPLE VI. Multiply 36.1 by 2.5

```
       36.1
        2.5
       -----
       18.05
       72.2
       -----
Answer 90.25
```

DIVISION OF DECIMALS.

Division of decimals is performed in the same manner as in whole numbers; only observing that the number of decimals in the quotient must be equal to the excess of the number of decimals of the dividend above those of the divisor.—When the divisor contains more decimals than the dividend, ciphers must be affixed to the right hand of the latter to make the number equal or exceed that of the divisor.

EXAMPLE I.

Divide 14.625 by 3.25

```
3.25)14.625(4.5
     1300
     ----
      1625
      1625
      ----
```

In this example there are 2 decimals in the divisor, and 3 in the dividend, hence there is one decimal in the quotient.

EXAMPLE II.

Divide 0.35 by 0.7

```
.7).35(.5
    .35
```

EXAMPLE III.

Divide 3.1 by .0062

Previous to the division I affix a number of ciphers to the right hand of 3.1, which does not alter its value.

```
.0062)3.100000(500.00
      310
      ----
      0000
```

Therefore the answer is 500.00 or 500.

EXAMPLE IV.

Divide 9.6 by .06

.06)9.60

160 Answer.

Here by affixing a cipher to 9.6 it becomes 9.60, and has then 2 decimals in it, which is the same number as is in the divisor, therefore the quotient is an *integer* number.

EXAMPLE V.

Divide 17.256 by 1.16

```
1.16)17.25600(14.875
     116
     ---
      565
      464
      ---
      1016
       928
      ----
        880
        812
        ---
         680
         580
         ---
         100
```

REDUCTION OF DECIMALS.

If you wish to reduce a vulgar fraction to a decimal, you may add any number of ciphers to the numerator, and divide it by the denominator, the quotient will be the decimal fraction; the decimal point must be so placed that there may be as many figures to the right hand of it as you added ciphers to the numerator; if there are not as many figures in the quotient, you must place ciphers to the left hand to make up the number.

EXAMPLE I. Reduce $\frac{1}{5}$ to a decimal.

5)1.0

.2 Answer.

EXAMPLE II. Reduce $\frac{3}{8}$ to a decimal.

8)3.000

.375 Answer.

EXAMPLE III. Reduce 3 inches to the decimal of a foot.

Since 12 inches=1 foot, this fraction is $\frac{3}{12}$.

12)3.00

.25 Answer.

EXAMPLE IV. Reduce $3\frac{1}{2}$ inches to the decimal of a foot.

$3\frac{1}{2}=\frac{7}{2}$: this divided by 12 is $\frac{7}{24}$.

```
24)7.000(.291 Answer.
   48
   ---
    220
    216
    ---
     40
     24
     --
     16
```

EXAMPLE V. Reduce 1 foot and 6 inches to the decimal of a yard.

Here 1 foot 6 inches=18 inches.

And 1 yard=36 inches, therefore this fraction is $\frac{18}{36}$.

```
36)18.0(.5 Answer.
   180
```

If you have any decimal fraction, it is easy to find its value in the lower denominations of the same quantity; thus if the fraction was the decimal of a yard, by multiplying it by 3 we have its value in feet and parts; if we multiply this by 12, the product is its value in inches and parts; and in the same manner the values may be obtained in other cases.

EXAMPLE VI.

Required the value of 3.25 yards.

```
3.25
   3
----
 .75
  12
----
9.00
```

Answer 3 yards, 0 feet, 9 inches.

EXAMPLE VII.

Required the value of 7.231 days.

```
 7.231
    24
 -----
   924
  462
 -----
 5.544
    60
 -----
32.640
    60
 -----
38.400
```

Answer 7 days, 5 hours, 32 minutes, and 38 seconds.

GEOMETRY.

GEOMETRY is the Science which treats of the description, properties, and relations of magnitudes in general, of which there are three kinds or species, viz. a line which has only length without either breadth or thickness; a superfices, comprehended by length and breadth, and a solid, which has length, breadth, and thickness.

I.

A POINT considered mathematically has no length, breadth, or thickness.

II.

A STRAIGHT LINE OR RIGHT LINE, is the shortest distance between the two points which limits its length, as A———C

III.

A PLANE SUPERFICES is that in which any two points being taken, the straight line between them lies wholly in that surface.

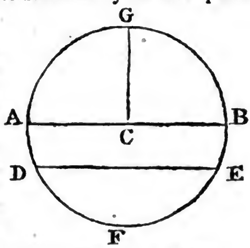
IV.

PARALLEL LINES are such as are in the same plane and which extended infinitely do never meet, as AB, DC.

A———B
D———C

V.

A CIRCLE is a plane figure, bounded by an uniform curve line; it is commonly described with a pair of compasses; one point of which is fixed, whilst the other is turned round to the place where the motion first began; the fixed point is called the CENTRE, and the line described by the other point is called the CIRCUMFERENCE.



VI.

The RADIUS of a circle, or SEMIDIAMETER, is a right line drawn from the centre to the circumference, as AC; or it is that line which is taken between the points of the compasses to describe the circle.

A DIAMETER of a circle is a right line drawn through the centre and terminated at both ends by the circumference, as ACB, and is the double of the radius AC. A diameter divides the circle, and its circumference into two equal parts.

VII.

An ARCH of a circle is any part or portion of the circumference, as DFE.

VIII.

The CHORD of an arch is a straight line joining the ends of the arch; it divides the circle into two unequal parts, called SEGMENTS, and is a chord to them both, as DE is the chord of the arches DFE and DGE.

IX.

A SEMICIRCLE, or half circle, is a figure contained under a diameter and the arch terminated by that diameter, as AGB or AFB. Any part of a circle contained between two radii and an arch, is called a SECTOR.

X.

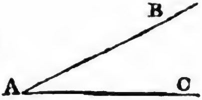
A QUADRANT is half a semicircle, or one-fourth part of a whole circle, as the figure CAG.

NOTE. All circles, whether great or small, are supposed to have their circumference divided into 360 equal parts, called degrees, and each degree into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds, and so on into thirds, fourths,* &c. and an arch is said to be of as many degrees as it contains parts of the 360, into which the circumference is divided.

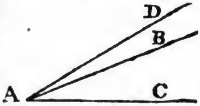
* A new division of the circumference of the circle has lately been adopted by several eminent French mathematicians, in which the quadrant is divided into 100°, each degree into 100′, each minute into 100″, &c. and tables of logarithms have been published conformable thereto. The general adoption of this division would tend greatly to facilitate most of the calculations of navigation and astronomy.

XI.

An Angle is the inclination of two lines which meet, but not in the same direction.

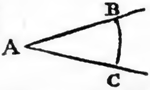


An angle is usually expressed by the letter placed at the angular point, as the angle A. But when two or more angles are at the same point, it is then necessary to express each by three letters, and the letter at the angular point is placed between the two. Thus, the angle formed by the lines AB, AC, is called the angle BAC or CAB, and that formed by AB, AD, is called the angle BAD, or DAB.



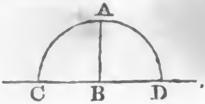
An angle is measured by the arch of a circle comprehended between the two legs that form the angle, the centre of the circle being the angular point.

Thus the angle A is measured by the arch BC described round the point A as a centre, and the angle is said to be of as many degrees as the arch is, that is, if the arch BC is 30°, then the angle BAC, is said to be an angle of 30 degrees.



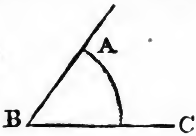
XII.

If a right line AB, fall upon another DC, so as to incline neither to the one side nor the other, but makes the angles ABC, ABD, equal to each other; then the line AB is said to be *perpendicular* to the line DC, and each of these angles is called a *right angle*, being each equal to a quadrant or 90°; because the sum of the two angles ABC, ABD, is measured by the semicircle DAC, described on the diameter DBC, and centre B.



XIII.

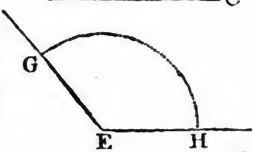
An Acute Angle is less than a right angle, as ABC.



XIV.

An Obtuse Angle is greater than a right angle, as GEH.

The least number of right lines that can include a space, are three which form a figure called a *Triangle*, consisting of six parts, viz. three sides and three angles: it is distinguished into three sorts, viz. a right angled triangle, an obtuse-angled triangle, and an acute-angled triangle.

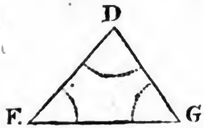


XV.

A Right-angled Triangle has one of its angles right; the side opposite the right angle is called the *hypotenuse*; and the other two sides are called legs; that which stands upright, is called the *perpendicular*, and the other the *base*; thus BC is the hypotenuse, AC the perpendicular, and AB the base; the angles opposite the two legs are both acute.

XVI.

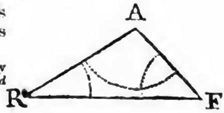
An Acute-angled Triangle has each of its angles acute, as DEG.



XVII.

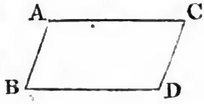
An Obtuse-Angled Triangle has one of its angles obtuse, or greater than a right angle, as RAF; the other two angles are acute.

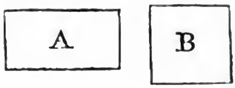
NOTE. All triangles that are not right angled, whether they are acute or obtuse, are in general terms called *oblique-angled triangles*, without any other distinction.



XVIII.

A Quadrilateral figure is one bounded by four sides, as ACDB. If the opposite sides are parallel they are called parallelograms. Thus if AC be parallel to BD, and AB parallel to CD, the figure ACDB is a parallelogram. A parallelogram having all its sides equal, and its angles right, is called a square, as B. When the angles are right, and the opposite sides only equal, it is called a rectangle, as A.



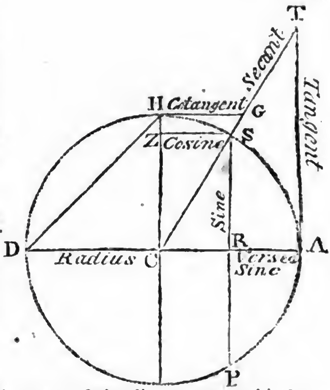


XIX.

The Sine of an arch is a line drawn from one end of the arch perpendicular to a diameter drawn through the other end of the same arch; thus RS is the sine of the arch AS, RS being a line drawn from one end S of that arch, perpendicular to DA which is the diameter passing through the other end A of the arch.

XX.

The Co-sine of an arch is the sine of the *complement* of that *arch*, or of what that arch wants of a quadrant; thus AH being a quadrant, the arch SH is the complement of the arch AS; SZ is the sine of the arch SH, or the co-sine of the arch AS.



XXI.

The Versed Sine of an arch is that part of the diameter contained between the sine and the arch; thus RA is the versed sine of the arch AS, and DCR is the versed sine of the arch DHS.

XXII.

The Tangent of an arch is a right line drawn perpendicular to the diameter passing through one end of the arch, and terminated by a line drawn from the centre through the other end of the arch; thus AT is the tangent of the arch AS.

XXIII.

The Co-tangent of an arch is the tangent of the complement of that arch to a quadrant; thus HG is the tangent of the arch HS or the co-tangent of the arch AS.

XXIV.

The Secant of an arch is a right line drawn from the centre through one end of the arch to meet the tangent drawn from the other end: thus CT is the secant of the arch AS.

XXV.

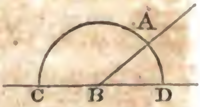
The Co-secant of an arch is the secant of the complement of that arch to a quadrant, thus CG is the secant of the arch SH, or co-secant of the arch AS.

XXVI.

What an arch wants of a semicircle is called the Supplement of the arch, thus, the arch DHS is the supplement of the arch AS. The sine, tangent, or secant of an arch, is the same as the sine, tangent, or secant of its supplement; thus, the sine of 80°=sine of 100°, and the sine of 70°=sine of 110°, &c.

XXVII.

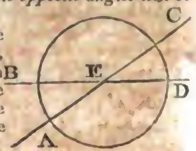
If one line AB *fall any way upon another* CD, *the sum of the two angles* ABD, ABC *is always equal to two right angles.*



For on the point B as a centre, describe the circular arch CAD, cutting the line CD in C and D; then *(by art. 6)* this arch is equal to a semicircle, but it is also equal to the sum of the arches CA and AD, the measures of the two angles ABC, ABD; therefore the sum of the two angles is equal to a semicircle, or two right angles. Hence it is evident that all the angles which can be made from a point in any line, towards one side of the line, are equal to two right angles, and that all the angles which can be made about a point, are equal to four right angles.

XXVIII.

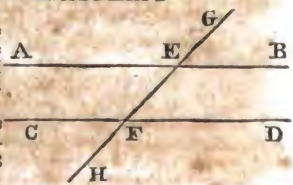
If a line AC *cross another* BD *in the point* E, *the opposite angles will be equal*, viz. BEA=CED, *and* BEC=AED.



Upon the point E as a centre, describe the circle ABCD; then it is evident that ABC is a semicircle, as also BCD *(by the 6th)* therefore the arch ABC=arch BCD, taking from both the common arch BC, there remains AB=CD, that is, the angle BEA equal to the angle CED. After the same manner we may prove that the angle BEC is equal to the angle AED.

XXIX.

If a line GH *cross two parallel lines*, AB, CD, *it makes the external opposite angles equal to each other*, viz. GEB=CFH *and* AEG=HFD.



For since AB and CD are parallel to each other, they may be considered as one broad line, and GH crossing it; then the vertical or opposite angles GEB, CFH are equal *(by art. 28)* as also AEG=HFD.

XXX.

If a line GH *cross two parallel lines* AB, CD (see the figure) *the alternate angles* AEF *and* EFD, *or* CFE *and* FEB *are equal.*

For GEB=AEF *(art. 28)* as also CFH=EFD *(by the same art.)* but GEB=CFH by the last. Therefore AEF is equal to EFD; in the same way may we prove FEB=CFE.

XXXI.

If a line GH *cross two parallel lines* AB, CD (see the preceding figure) *the external angle* GEB *is equal to the internal opposite one* EFD, *or* AEG *equal to* CFE.

For the angle AEF is equal to the angle EFD by the last, and AEF=GEB *(by art. 28)* therefore GEB=EFD; in the same way we may prove AEG=CFE.

XXXII.

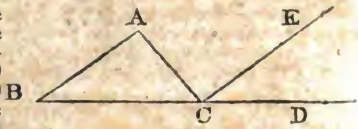
If a line GH *cross two parallel lines* AB, CD (see the preceding figure) *the sum of the two internal angles* BEF *and* DFE, *or* AEF *and* CFE *is equal to two right angles.*

For since the angle GEB is equal to the angle EFD *(by the last)* to both

add the angle BEF, and we have GEB+BEF=BEF+EFD, but GEB+BEF=two right angles *(art. 27.)* Hence BEF+EFD=two right angles: and in the same manner we may prove AEF+CFE=two right angles.

XXXIII.

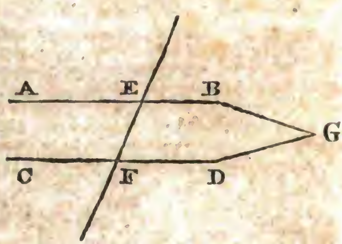
In any triangle ABC, *one of its legs, as* BC *being produced towards* D, *the external angle* ACD *is equal to the sum of the internal and opposite angles* ABC, BAC.



To prove this, through C draw CE parallel to AB; then since CE is parallel to AB and the lines AC, BD cross them, the angle ECD=ABC *(by article 31)* and ACE=BAC *(by article 30)* adding these together we have ECD+ACE=ABC+BAC; but ECD+ACE=ACD, therefore ACD=ABC+BAC.

XXXIV.

Hence it may be proved that if any two lines AB *and* CD, *be crossed by a third line* EF, *and the alternate angles* AEF *and* EFD *be equal, the lines* AB *and* CD *will be parallel.*



For if they are not parallel, they must meet each other on one side of the line EF (suppose at G) and so form the triangle EGF, one of whose sides, GE being produced to A, the exterior angle AEF must (by the preceding article) be equal to the sum of the two angles EFG and EGF; but by supposition it is equal to the angle EFG alone; therefore the angle AEF must be equal to the sum of the two angles EFG and EGF, and at the same time equal to EFG alone, which is absurd; therefore the lines AB, CD cannot meet, and must be parallel.

XXXV.

In any right lined triangle ABC, *the sum of the three angles is equal to two right angles.*

To prove this, you must produce BC *(in the fig. art. 33,)* towards D, then *(by art. 33)* the external angle ACD=ABC+BAC, to both add the angle ACB and we have ACD+ACB=ABC+BAC+ACB, but ACD+ACB=two right angles *(by art. 27.)* Hence ABC+BAC+ACB=two right angles; therefore the sum of the three angles of any plain triangle ACB is equal to two right angles.

XXXVI.

Hence in any plain triangle, if one of its angles be known, the sum of the other two will be also known.

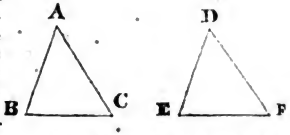
For by the last article the sum of all three angles is equal to two right angles or 180°, hence, by subtracting the given angle from 180°, the remainder will be the sum of the other two.

In any right angled triangle, the two acute angles taken together are just equal to a right angle: for all three angles being equal to two right angles, and one angle being right by supposition, the sum of the other two must be equal to a right angle, consequently any one of the acute angles being given, the other one may be found, by subtracting the given one from 90 degrees.

XXXVII.

If in any two triangles ABC, DEF, *two legs of the one,* AB, AC, *be equal to two legs of the other* DE, DF, *each to each respectively, that is* AB=DE *and*

$AC=DF$, *and the angles* BAC, EDF *included between the equal legs be equal; then the remaining leg of the one will be equal to the remaining leg of the other, and the angles opposite to the equal legs will be equal, that is,* $BC=EF$, $ABC=DEF$, *and* $ACB=DFE$.



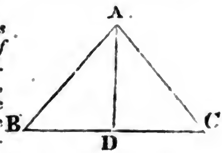
For if the triangle ABC be supposed to be lifted up and put upon the triangle DEF, with the point A on the point D and the line AB upon DE; it is plain, since $AB=DE$, that the point B will fall upon E, and since the angles BAC, EDF are equal, the line AC will fall upon DF, and these lines being of equal length, the point C will fall upon F, consequently the line BC will fall exactly upon the line EF, and the triangle ABC will in all respects be exactly equal to the triangle DEF, and the angle ABC will be equal to the angle DEF, also the angle ACB will be equal to the angle DFE.

XXXVIII.

After the same manner it may be proved that if in any two triangles ABC, DEF (see the preceding figure) *two angles* ABC *and* ACB *of the one, be equal to two angles* DEF, DFE *of the other, and the included side* BC *be equal to* EF; *the remaining sides and included angles will also be equal to each other respectively, that is,* $AB=DE$, $AC=DF$, *and the angle* BAC $=$ *angle* EDF.

For if the triangle ABC be supposed to be lifted up and laid upon the triangle DEF, the point B being upon the point E, and the line BC upon the line EF; then since $BC=EF$ the point C will fall upon the point F, and since the angle $ACB=$ the angle DFE, the line CA will fall upon the line FD, and by the same way of reasoning, the line BA will fall upon the line ED, therefore the point of intersection A of the two lines BA, CA, will fall upon D, the point of intersection of the lines ED, FD, consequently $AB=DE$, $AC=DF$, and the angle $BAC=$ the angle EDF.

XXXIX.



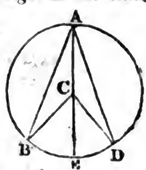
If two sides of a triangle are equal, the angles opposite these sides will also be equal; that is, if $AB=AC$, *the angles* ABC, ACB *will also be equal.*

For draw the line AD bisecting the angle BAC, and meeting the line BC in D, dividing the triangle BAC into two triangles ABD, ACD, in which the side $AB=AC$, the side AD is common to both triangles, and the angle $BAD=$ the angle DAC; consequently *(by art.* 37*)* the angle ABD must be equal to the angle ACD.

The converse of this proposition is also true; that is, *if two angles of a triangle are equal, the opposite sides are also equal.* This is demonstrated nearly in the same manner by means of *art.* 38.

XL.

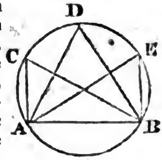
Any angle at the circumference of a circle is half the angle at the centre standing upon the same arch.



Thus, the angle BAD is half the angle BCD standing upon the same arch BD of the circle BEDA, whose centre is C. To demonstrate this, draw through A and the centre C the right line ACE, then *(by art.* 33*)* the angle CAD $+$ angle CDA $=$ angle ECD, but $AC=CD$ (being two radii of the same circle) therefore *(by art.* 39*)* the angle $CAD=$ the angle CDA, and the sum of these two angles is the double of either of them, that is, $CAD+CDA=$ twice CAD, therefore $ECD=$ twice CAD; in the same manner it may be proved that $BCE=$ twice BAC, and by adding these together, we have $ECD+BCE=$ twice CAD $+$ twice BAC, that is, $BCD=$ twice BAD, or BAD equal to half of BCD. The demonstration is similar when B, D, fall on the same side of E.

XLI.

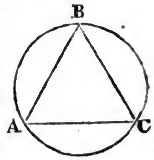
An angle at the circumference is measured by half the arch it subtends.



For an angle at the centre standing on the same arch is measured by the whole arch *(by art.* 11*)*; but since an angle at the centre is double that at the circumference, *(art.* 40*)* it is evident that an angle at the circumference must be measured by half the arch it stands upon. *Hence all angles* ACB, ADB, AEB, &c. *at the circumference of a circle standing on the same chord* AB *are equal to each other;* for they are all measured by the same arch, viz. half the arch AB.

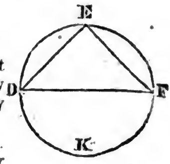
XLII.

An angle in a segment greater than a semicircle is less than a right angle.



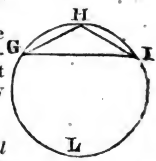
Thus if ABC be a segment greater than a semicircle, the arch AC on which it stands must be less than a semicircle, and the half of it less than a quadrant or a right angle; but the angle ABC in the segment is measured by the half of the arch AC; therefore it is less than a right angle.

An angle in a semicircle is a right angle.



For since DEF is a semicircle, the arch DKF must also be a semicircle; but the angle DEF is measured by half the arch DKF, that is, by half a semicircle or by a quadrant; therefore the angle DEF is a right one.

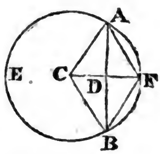
An angle in a segment less than a semicircle is greater than a right angle.



Thus if GHI be a segment less than a semicircle, the arch GLI on which it stands must be greater than a semicircle, and its half greater than a quadrant or right angle: therefore the angle GHI which is measured by half the arch GLI is greater than a right angle.

XLIII.

If from the centre C of the circle ABE, there be let fall the perpendicular CD on the chord AB; it will bisect the chord in the point D.



Draw the radii CA, CB, then *(by art.* 39*)* the angle CBA=the angle CAB, and as the angles at D are right, the angle ACD must be equal to the angle BCD *(by art.* 36.*)* Hence in the triangles ACD, BCD, we have the angle ACD equal to the angle BCD, CA=CB and CD common to both triangles, consequently *(by art.* 37*)* AD=DB, that is, AB is bisected at D.

XLIV.

If from the centre C of the circle ABE there be drawn a perpendicular CD, *to the chord AB, and it be continued to meet the circle in F,* it will bisect the arch AFB in F. (See the preceding figures)

For in the last article it was proved that the angle ACD=the angle BCD, hence *(by art.* 11*)* the arch AF=the arch FB.

XLV.

Any line bisecting a chord at right angles is a diameter.

For since *(by art.* 43*)* a line drawn from the centre perpendicular to a chord, bisects that chord at right angles, therefore conversely a line bisecting a chord at right angles, must pass through the centre, and consequently be a diameter.

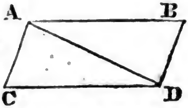
XLVI.

The sine of any arch is equal to half the chord of twice that arch.

For *(in the last scheme)* AD is the sine of the arch AF, and AF is equal to half the arch AFB and AD half the chord AB, whence the proposition is manifest.

XLVII.

If two equal and parallel lines AB, CD, be joined by two others, AC, BD, these will be also equal and parallel.



To demonstrate this, join the two opposite angles A and D with the line AD; then it is evident that the line AD divides the quadrilateral ACDB into two triangles ABD, ACD, in which AB is equal to CD by supposition, and AD is common to both triangles; and since AB is parallel to CD, the angle BAD is equal to the angle ADC *(by art. 30)*, therefore in the two triangles, the sides AB, AD, and the angle BAD are equal respectively to the sides CD, AD, and the angle ADC; hence *(by art. 37)* BD is equal to AC, and the angle DAC equal to the angle ADB; therefore *(by art. 34)* the lines BD, AC, must be parallel.

Cor. Hence it follows that the quadrilateral ABDC is a parallelogram, since the opposite sides are parallel. It is also evident that in any parallelogram, the line joining the opposite angles (called the *diagonal*) as AD, divides the figure into two equal parts, since it has been proved that the triangles ABD, ACD, are equal to each other.

XLVIII.

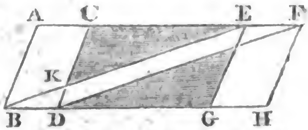
It follows also from the preceding article, that *a triangle ACD (see the preceding figure) on the same base, and between the same parallels with a parallelogram ABDC, is the half of that parallelogram.*

XLIX.

From the same article it also follows, that *the opposite sides of a parallelogram are equal.* For it has been proved, that ABDC being a parallelogram, AB is equal to CD, and AC equal to BD.

L.

All parallelograms on the same or equal bases, and between the same parallels, are equal to each other; that is, if BD and GH be equal, and the lines BH, AF be parallel, the parallelograms ABDC, BDFE and EFHG will be equal to each other.



For AC is equal to EF each being equal to BD *(by art. 49)* to both add CE and we have AE equal to CF; therefore in the two triangles ABE, CDF; AB is equal to CD, and AE is equal to CF, and the angle BAE is equal to DCF *(by art. 31,)* therefore the two triangles ABE, CDF are equal *(by art. 37)* and taking the triangle CKE from both, the figure ABKC is equal to the figure KDFE, to both which add the little triangle KBD, and we have the parallelogram ABDC equal to the parallelogram BDFE. In the same way it may be proved that the parallelogram EFHG is equal to the parallelogram BDFE; therefore the three parallelograms ABDC, BDFE, and EFHG are equal to each other.

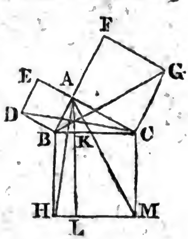
Cor. Hence it follows, that *triangles on the same base and between the same parallels are equal,* since they are the half of the parallelograms on the same base and between the same parallels *(by art. 48.)*

LI.

In any right angled triangle, the square of the hypotenuse is equal to the sum of the squares of the two sides. Thus if BAC be a right angled triangle the square of the hypotenuse BC, viz. BCMH, is equal to the sum of the squares made on the two sides AB and AC, viz. to ABDE and ACGF.

To demonstrate this, through the point A draw AKL perpendicular to the hypotenuse BC. Join AH, AM, DC, and BG; then it is evident, that DB

is equal to BA *(by art.* 18*)* and BH equal to BC, therefore in the triangles DBC, ABH, the two legs DB, BC of the one are equal to the two legs AB, BH, of the other; and the included angles DBC and ABH are also equal, (for DBA is equal to CBH being both right, to each add ABC and we have DBC equal to ABH) therefore the triangles DBC, ABH are equal *(by art.* 37*)* but the triangle DBC is half of the square ABDE *(by art.* 48*)* and the triangle ABH is half the parallelogram BKLH *(by the same art.)* consequently the square ABDE is equal to the parallelogram BKLH. In the same way it may be proved that the square ACGF is equal to the parallelogram KCML. Therefore the sum of the squares ABDE and ACGF is equal to the sum of the parallelograms BKLH and KCML; but the sum of these parallelograms is equal to the square BCMH, therefore the sum of the squares on AB and AC is equal to the square on BC.



Cor. Hence in any right angled triangle, if we have the hypotenuse and one of the legs, we may easily find the other leg, by taking the square of the given leg from the square of the hypotenuse, the square root of the remainder will be the sought leg. Thus if the hypotenuse was 13, and one leg was 5, the other leg would be 12, for the square of 5 is 25, and the square of 13 is 169, subtracting 25 from 169 leaves 144, the square root of which is 12. If both legs are given, the hypotenuse may also be found by extracting the square root of the sum of the squares of the legs; thus if one leg was 6, and the other 8, the square of the first is 36, the square of the second is 64, adding 36 and 64 together gives 100, whose square root is 10, which is the sought hypotenuse.

LII.

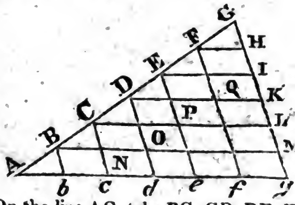
Four quantities are said to be proportional, when the magnitude of the first compared with the second is the same as the magnitude of the third compared with the fourth.

Thus 4, 8, 12 and 24, are proportional, because 4 is half of 8, and 12 is half of 24; and if we take equi-multiples $A\times a$, $A\times b$, of the quantities a and b, and other equi-multiples $B\times a$, $B\times b$, of the same quantities a and b, the four quantities $A\times a$, $A\times b$, $B\times a$, $B\times b$ will be proportional, for $A\times a$ compared with $A\times b$ is of the same magnitude as a compared with b, and $B\times a$ compared with $B\times b$ is also of the same magnitude as a compared with b.

LIII.

In any triangle AGg *if a line* Ee *be drawn parallel to either of the sides as* Gg, *the side* Ag *will be to* AE, *as* Ag *to* Ae, *or as* Gg *to* Ee.

To demonstrate this, upon the line AG take the line AB so that a certain multiple of it may be equal to AE, and another multiple of it may be equal to AG; this may be always done accurately when AE and AG are commensurable; if they are not accurately commensurable, the quantity AB may be taken so small that certain multiples of it may differ from AE and AG respectively by quantities less than any assignable.

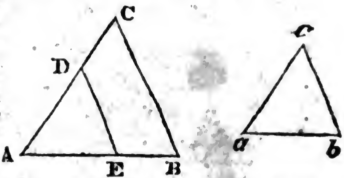


On the line AG, take BC, CD, DE, EF, FG, &c. each equal to AB, and through these points draw the lines Bb, Cc, &c. parallel to Gg, cutting the line Ag in the points b, c, d, e, &c. draw also the lines BM, CL, DK, &c. parallel to Ag, cutting the former parallels in the points N, O, P, &c. and the line Gg in the points M, L, K, &c. Then the triangles ABb, BCN, CDO, &c. are similar and equal to each other: for the lines Bb, CN are parallel, therefore the angle ABb=BCN *(by art.* 31*)* and

by the same article the angle BAb is equal to CBN (because BN is parallel to Ab) and by construction AB=BC, therefore *(by art. 38)* the triangles ABb and BCN are equal to each other; and in the same manner we may prove that the others CDO, DEP, EFQ, &c. are equal to ABb. Therefore Ab=BN=CO=DP, &c. and Bb=CN=DO=EP, &c. but *(by art. 49)* BN=Bc, CO=cd, DP=de; therefore Ab=bc=cd=de, &c. and since *(by construction)* AB=BC=CD, &c. any line AE is the same multiple of AB as the corresponding line Ae is of Ab; and AG is the same multiple of AB as Ag is of Ab; therefore the lines AG, AE, Ag, Ae, are proportional *(by art. 52;)* that is, AG is to AE as Ag is to Ae; and in a similar manner we may prove that AG is to AE as Gg is to Ee.

LIV.

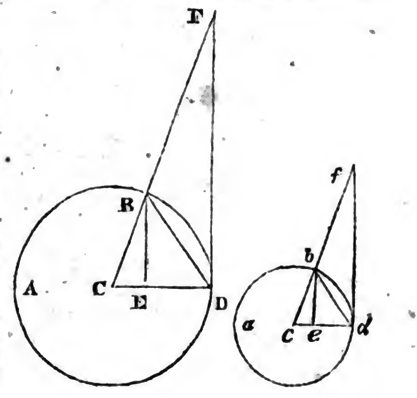
If any two triangles, ABC, abc, are similar, or have all the angles of the one, equal to all the angles of the other, each to each respectively, that is, CAB=cab, ACB=acb, ABC=abc; the legs opposite to the equal angles will be proportional, viz. AB : ab : : AC : ac; AB : ab : : BC : bc; and AC : ac : : BC : bc.



To prove this, set off upon a side AB of the largest triangle AE=ab, and through E draw ED parallel to BC, to meet AC in D, then since DE, BC are parallel, the angle AED is equal to ABC *(by art. 31)* and this *(by supposition)* is equal to the angle abc; also the angle DAE is *(by supposition)* equal to cab; therefore in the triangles ADE, abc, the two angles DAE, AED of the one, are equal to the two angles cab, abc of the other, each to each respectively, and the included side AE is *(by construction)* equal to the included side ab; therefore *(by art. 38)* AD is equal to ac, and DE equal to bc: but since in the triangle ABC there is drawn DE parallel to BC one of its sides, to meet the other two sides in the points DE; therefore *(by the preceding art.)* AB : AE : : AC : AD, and AB : AE : : BC : DE, and AC : AD : : BC : DE; if in these three proportions for DE we put its equal bc, for AE put ab, and for AD put ac; they will become AB : ab : : AC : ac, and AB : ab : : BC : bc, and AC : ac : : BC : bc.

LV.

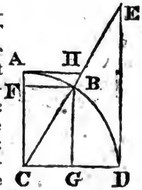
The chord, sine, tangent, &c. of any arch in one circle, is to the chord, sine, tangent, &c. of the same arch in another, as the radius of the one is to the radius of the other.



Let ABD, abd, be two circles; BD, bd, two arches of these circles, equal to one another, or consisting of the same number of degrees;—FD, fd, the tangents; Bd, bd, the chords; BE, be, the sines, &c. of these two arches BD, bd, and CD, cd, the radii of the circles; then CD : cd : : FD : fd, and CD : cd : : BD : bd, and CD : cd : : BE : be, &c. For since the arches BD, bd, are equal, the angles BCD, bcd, are also equal, and FD, fd, being tangents to the points D and d, the angles CDF, cdf are each equal to a right angle *(by art. 22;)*

therefore since in the two triangles CDF, cdf, the two angles FCD, CDF of the one, are equal to the two angles fcd, cdf, of the other, each to each, the remaining angle CFD is also equal to the remaining angle cfd, *(by art.* 36;*)* consequently the triangles CFD, cfd, are similar. The triangles BCD, bcd are also similar, for the angle CBD is equal to the angle CDB, being each subtended by the radius; therefore *(by art.* 36*)* each of these angles is equal to half the supplement of the angle BCD; and in the same manner the angle cbd or cdb is equal to half the supplement of the angle bcd, and since the angle BCD is equal to bcd, the angles of these two triangles must be equal, consequently they are similar. The triangles BCE, bce are also similar, because BE is parallel to FD, and be parallel to fd. Hence we obtain *(by art.* 54*)* the following analogies. CD : cd : : FD : fd; CD : cd : : BD : bd; CB : cb : : BE : be, &c.

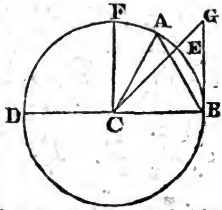
LVI.



Let ABD be a quadrant of a circle, described by the radius CD, BD any arch of it, BA its complement, BG or CF the sine, CG or BF the co-sine, DE the tangent, AH the co-tangent, CE the secant, and CH the co-secant of that arch BD. Then since the triangles CDE, CGB, are similar or equi-angular we shall have *(by art.* 54*)* DE : CE : : BG : CB, that is, the tangent of an arch, is to secant of the same, as the sine of it is to radius. Also, CE : CD : : CB : CG; that is, the secant is to radius as the radius to the co-sine of an arch. Also, CF : CA : : CB : CH, that is, the sine is to radius as radius to the co-secant of an arch; and since the triangle CAH is similar to the triangle CDE, we have AH : CA : : CD : DE, that is, the co-tangent is to the radius as the radius to the tangent of an arch.

LVII.

In all circles, the sine of 90°, *the tangent of* 45°, *and the chord of* 60°, *are each equal to the radius.*

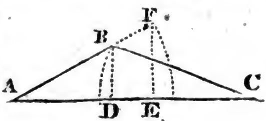


For in the circle DFAEB, let the arch BE be 45°, the arch BA 60°, and BF 90°. Draw through the centre C the diameter DCB and perpendicular thereto the tangent BG meeting CE produced in G; draw the chord BA, and join CF, CA.—Then since the arch BF is 90°, DF must be 90°, whence *(by art.* 12 & 19*)* the radius CF is equal to the sine of the arch BF, or sine of 90°. Again, in the triangle CBG, since the angle CBG is 90°, and BCG is 45° by supposition, the angle CGB is also 45° *(by art.* 36*)* therefore *(by art.* 39*)* BG is equal to CB, that is, the tangent of 45° is equal to the radius. Again, the angle ACB is 60° (being measured by the arch BA) and the angle CBA is also 60° (being measured by half the arch AD=120° by art. 40) therefore *(by art.* 39*)* CA=AB, that is, the chord of 60° is equal to the radius.

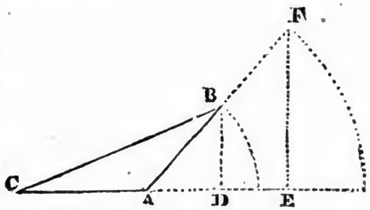
The four following propositions contain the demonstration of the rules by which all the calculations of trigonometry may be made; they were inserted here in order to prevent any embarrassment of the young calculator, from the introduction of the demonstrations among the precepts for calculation.

LVIII.

In any plane triangle, the sides are proportional to the sines of the opposite angles.



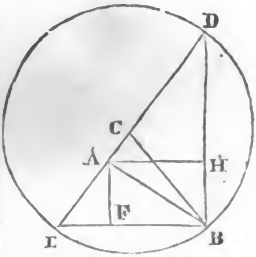
Let ABC be the triangle; produce the lesser side AB to F, making AF equal to BC; from B and F let fall the perpendiculars BD, FE, upon AC (produced if necessary;) then FE is the sine of the angle A, and BD is the sine of the angle C, the



radius being BC equal to AF; now the triangles ABD, AFE, having the angle A common to both, and the angle D equal to the angle E (being each equal to a right angle) are similar; hence *(by art.* 54*)* as AF (or its equal BC) is to AB, so is FE to BD; that is, BC is to AB as the sine of the angle A is to the sine of the angle C.

LIX.

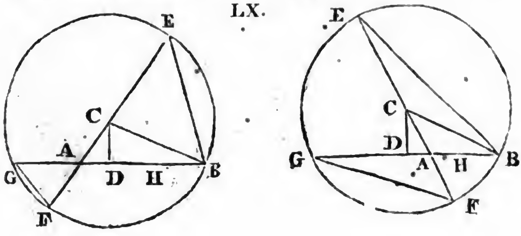
In any triangle (supposing any side to be the base, and calling the other two the sides) the sum of the sides is to their difference, as the tangent of half the sum of the angles at the base is to the tangent of half the difference of the same angles.



Thus, in the triangle ABC, if we call AB the base, it will be as the sum of AC and CB is to their difference, so is the tangent of half the sum of the angles ABC, BAC, to the tangent of half their difference.

Dem. With the longest leg CB as radius, describe a circle about the centre C, meeting the shorter side AC (produced on each side) in the points D and E, join EB, DB; draw AH perpendicular to DB, and AF perpendicular to EB; then *(by art.* 42*)* the angle EBD, being in a semi-circle, is a right angle; and the triangles AHD, AFE, are similar, and AF is equal to HB. Moreover, since CB is equal to CD or CE, AD is the sum and AE is the difference of the legs AC, CB; likewise *(by art.* 33*)* the angle BCD is equal to the sum of the angles BAC, ABC, and therefore *(by art.* 40*)* the angle DEB, or its equal DAH, is equal to half the sum of the angles at the base ABC, BAC. Again *(by art.* 33*)* the angle BAC is equal to the sum of the angles CEB (or CBE) and ABE, and therefore is equal to the sum of the angle ABC, and twice the angle ABE; hence the angle ABE or its equal BAH, is equal to half the difference of the angles at the base. But in the right angled triangles AHD, AHB, making AH radius, the legs DH, HB are the tangents of the angles DAH, BAH, or the tangents of half the sum and half the difference of the angles at the base; but by reason of the similar triangles AHD, AFE, we have AD : AE : : DH : AF or HB; that is, AD, the sum of the legs AC and CB, is to AE their difference, as DH the tangent of half the sum of the angles at the base (the radius being AH) is to HB the tangent of half the difference of the same angles, (to the same radius,) and therefore *(by art.* 55*)* as the tabular tangent of half the sum of the angles at the base is to the tabular tangent of half the difference of the same angles.

LX.

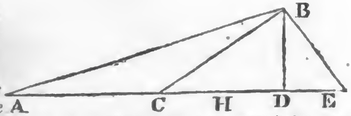


In any plane triangle ABC, if the line CD be drawn perpendicular to the base AB, dividing it into two segments, AD, DB, and the base AB be bisected in the point H, we shall have,

As the base AB is to the sum of the sides, AC, BC, so is the difference of the sides to twice the distance DH of the perpendicular from the middle of the base.

Dem. With the greater side CB as radius, describe about the centre C the circle BFGE, meeting the other side produced in the points E and F, and the base AB produced in G; join GF and BE. Then AE is the sum, and AF the difference of the sides AC, CB; and since CD is perpendicular to GB, the line GB is bisected in D (*by art.* 48) and as AB is bisected in H, the line AG is equal to twice DH. Now in the triangles BAE, GAF, the angles ABE, GFA are equal (*by art.* 41) and the angle BAE is equal to GAF (*by art.* 28) therefore the remaining angles AEB, AGF, are equal, and the triangles BAE, GAF, are similar; consequently (*by art.* 54) AB : AE : : AF : AG, or twice HD, which is the proposition to be demonstrated. Having thus obtained HD, we may find the segments AD, DB, by adding HD to the half base HA or HB and by taking their difference.

LXI.



In any plane triangle, the square of radius is to the square of the co-sine of half of either of the angles, as the rectangle contained by the two sides including that angle is to the rectangle contained by the half sum of the sides, and that half sum decreased by the side opposite to that angle.

Thus in the triangle CBE, the square of radius is to the square of the co-sine of half the angle C, as the rectangle $CB \times CE$ is to $\frac{CB+CE+BE}{2} \times \frac{CB+CE-BE}{2}$.

For continue EC to A, making $CA=CB$, draw BD perpendicular to CE, bisect CE in H, and join AB. Then (supposing CB to be greater than EB) we have (by art. 60) $CE : CB+BE :: CB-BE : \frac{CB^2-BE^2}{CE} = 2.HD$; by adding half this to half the base$=$CH, we have the segment $CD=\frac{CB^2-BE^2+CE^2}{2.CE}$ to this adding CA or CB, we have $AD=\frac{CB^2-BE^2+CE^2+2CE\cdot CB}{2.CE}=$

$\frac{\overline{CB+CE}|^2-BE^2}{2.CE}=\frac{\overline{CB+CE+BE}\times\overline{CB+CE-BE}}{2.CE}$ Again, $AD=AC+CD=CB+CD$;

hence $AD|^2=\overline{CB}^2+2CB\cdot CD+CD^2$; also, $BD^2=CB^2-CD^2$; hence $AB^2=AD^2+BD^2=2CB^2+2CB.CD=2CB\times\overline{CB+CD}=2CB \,.\, AD$; hence $AB^2 : AD^2 ::$

$2CB : AD=\frac{\overline{CB+CE+BE}\,.\,\overline{CB+CE-BE}}{2.CE}$; but AB being radius, AD is the co-sine of the angle A, which is equal to half the angle C (by art. 40 ;) therefore the square of radius is to square of the co-sine of half the angle C, as the rectangle CE.CB is to the rectangle $\frac{CB+CE+BE}{2} \times \frac{CB+CE-BE}{2}$

The other cases of this proposition may be demonstrated in the same manner.

GEOMETRICAL PROBLEMS.

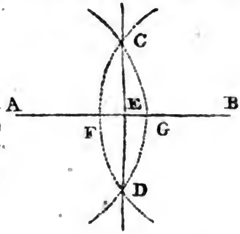
PROBLEM I.

To draw a Right Line CD parallel to a given Right Line AB, at any given distance, as at the point D.

With a pair of compasses take the nearest distance between the point D and the given right line AB; with that distance set one foot of the compasses any where on the line AB, as at A, and draw the arch C on the same side of the line AB as the point D, from the point D draw a line so as just to touch the arch C, and it is done; for the line CD will be parallel to the line AB, and at the distance of the point given D, as was required.

PROBLEM II.

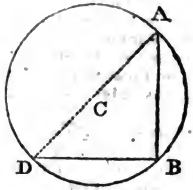
To bisect or divide a given line AB into two equal parts.



Take any distance in your compasses greater than half the line AB, then with one foot in B, describe the arch CFD; with the same distance, and one foot in A, describe the arch CGD, cutting the former arch in C and D; draw the line CD, and it will bisect AB in the point E.

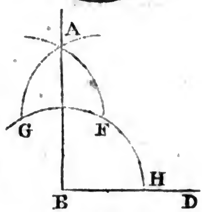
PROBLEM III.

To erect a perpendicular BA on the end of a given Right Line DB.



Take any extent in your compasses, and with one foot in B fix the other in any point C without the given line; then with one point of the compasses in C, describe with the other the circle ABD; through D and C draw the diameter DCA meeting the circle in A; join B and A and it is done; for BA will be the required line (*by art.* 42 *Geom.*)

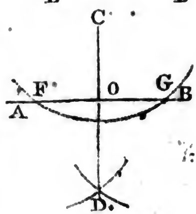
Or thus,



Take any convenient distance as BH in your compasses, and with one foot in B describe the arch HFG, upon which set off the same distance as a chord from H to F, and from F to G, upon F and G describe two arches intersecting each other in A; draw a line from B to A and it is done; for BA will be the perpendicular required.

PROBLEM IV.

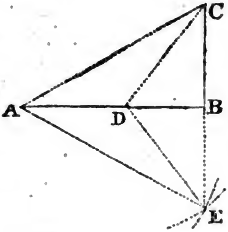
From a given point as C, to let fall a perpendicular CO, on a given Right Line AB.



Take any extent in your compasses greater than the least distance between C and the given line AB; with one foot in C, describe an arch to cut the given line AB in F and G;—with one foot in G describe an arch, and with the same distance, and one foot in F, describe another arch cutting the former in D; from C to D draw the line COD, cutting AB in O; then CO will be the perpendicular required.

PROBLEM V.

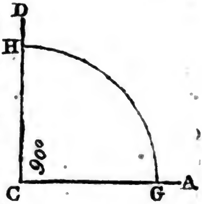
From a given point C to let fall a perpendicular CB on a given Line AB, when the perpendicular is to fall so near the end of the given line that it cannot be done as above.



Upon any point A of the line AB as a centre, and with the distance AC describe an arch E; choose any other point in the line AB, as D, and with the distance DC describe another arch intersecting the former in E, join CE cutting AB in B, and it is done, for CB will be the perpendicular required.

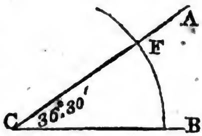
PROBLEM VI.

To make an angle that shall contain any proposed number of degrees, from a given point in a given line.



CASE 1. When the given angle is right, or contains 90° let CA be the given line, and C the given point.

On C erect a perpendicular CD, and it is done; for the angle DCA is an angle of 90°. Or thus, on the point C as a centre, with the chord of 60°* describe an arch GH, and set off thereon from G to H the distance of the chord of 90° and from C through H draw CHD, which will form the angle DCA of 90° required.

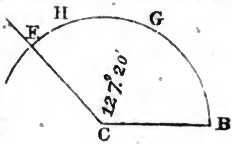


CASE 2. When the angle is acute, as for example $36^\circ\ 30'$ let CB be the given line and C the point at which the angle is to be made.

With the chord of 60° in your compasses, and one foot on C, as a centre, draw the arch FB, on which set off from B to F, the given angle $36\frac{1}{2}^\circ$ taken from the line of chords; through F and the centre C draw the right line AC, and it is done; for the angle ACB will be an angle of $36^\circ\ 30'$ as was required.

CASE 3. When the given angle is obtuse, as for example $127^\circ\ 20'$ let CB be the given line and C the angular point.

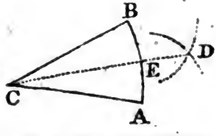
Take the chord of 60° in your compasses, and with one foot on C as a centre, describe an arch BGHE, upon which set off the chord of 60° (which you already have in your compasses) from B to G, and from G to H; then set off from G to E, the excess of the given angle above 60°, which is $67\frac{1}{3}^\circ$ taken from the line of chords; or you may set off from H to E, the excess of the given angle above 120°, which is $7\frac{1}{3}^\circ$; draw the line CE, and it is done, for the angle ECB will be an angle of $127^\circ\ 20'$.



Were it required to measure a given angle, the process would have been nearly the same, by sweeping an arch as BE, and measuring it on the line of chords, as is evident.

PROBLEM VII.

To bisect a given arch of a circle AB, whose centre is C.

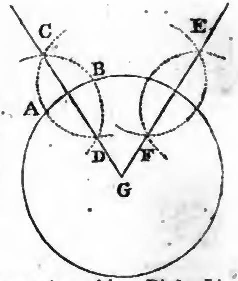


Take in your compasses any extent greater than the half of AB, and with one foot in A, describe an arch; with the same extent and one foot in B, describe another arch cutting the former in D; join CD and it is done, for this line will bisect the arch AB in the point E. It is also evident that the line CD bisects the angle BCA, or divides it into two equal parts.

* For a description of the line of Chords see page 20.

PROBLEM VIII.

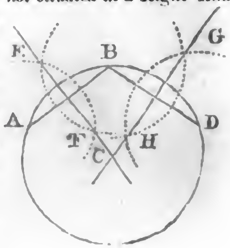
To find the centre of a given Circle.



With any radius, and one foot in the circumference as at A, describe an arch of a circle, as CBD, cutting the given circle in B; with the same extent, and one foot in B, describe another arch CAD, cutting the former in C and D; through C and D draw the line CD, which will pass through the centre of the circle; in like manner may another right line be drawn, as EFG, which shall cross the first right line at the centre required. This construction depends upon article 43 of Geometry.

PROBLEM IX.

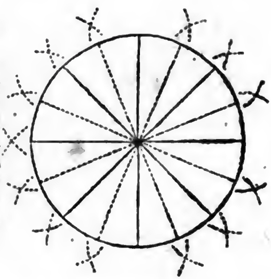
To draw a Circle through any three given points not situated in a Right Line.



Let A, B and D be the given points. Take in your compasses any distance greater than half AB, and with one foot in A describe an arch EF; with the same extent, and one foot in B, describe another arch cutting the former in the points E, F, through which draw the indefinite right line EFC; then take in your compasses any extent greater than half BD, and with one foot in B, describe an arch GH; with the same extent, and one foot in D, describe another arch cutting the former in the points G, H, through which draw the right line GHC, cutting the former right line EFC, in the point C; upon the point C as a centre, with an extent equal to CA, CB, or CD, as radius, describe the sought circle.

PROBLEM X.

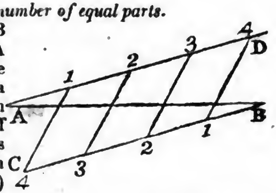
To divide a Circle into 2, 4, 8, 16, or 32, equal parts.



Draw a diameter through the centre, dividing the circle into two equal parts; bisect this diameter by another drawn perpendicular thereto, and the circle will be divided into four equal parts or quadrants; bisect each of these quadrants again by right lines drawn through the centre, and the circle will be divided into eight equal parts; and so you may continue the bisections any number of times. This problem is useful in constructing the mariner's compass.

PROBLEM XI.

To divide a given Line into any number of equal parts.



Let it be required to divide the line AB into five equal parts.—From the point A draw any line AD, making an angle with the line AB; then through the point B draw a line BC parallel to AD; and from A, with any small opening in your compasses, set off a number of equal parts on the line AD, less by one than the proposed number (which number of equal parts in this example is 4:) then from B set off the same number of the same parts on the line BC, then join 4 and 1, 3 and 2, 2 and 3, 1 and 4, and these lines will cut the given line as required.

CONSTRUCTION OF THE PLANE SCALE.

1st. WITH the radius you intend for your scale, describe a semicircle ADB, (Plate II. fig. 1.) and from the centre C draw CD perpendicular to AB, which will divide the semicircle into two quadrants, AD, BD; continue CD towards S, draw BT perpendicular to CB, and join BD and AD.

2dly. Divide the quadrant BD into 9 equal parts, then will each of these be 10 degrees; subdivide each of these parts into single degrees, and if your radius will admit of it, into minutes or some aliquot parts of a degree greater than minutes.

3dly. Set one foot of the compasses in B and transfer each of the divisions of the quadrant BD to the right line BD, then will BD be a line of chords.

4thly. From the points 10, 20, 30, &c. in the quadrant BD draw right lines parallel to CD, to cut the radius CB, and they will divide that line into a line of sines which must be numbered from C towards B.

5thly. If the same line of sines be numbered from B towards C, it will become a line of versed sines, which may be continued to 180°, if the same divisions be transferred on the same line on the other side of the centre C.

6thly. From the centre C, through the several divisions of the quadrant BD, draw right lines till they cut the tangent BT, so will the line BT become a line of tangents.

7thly. Setting one foot of the compasses in C, extend the other to the several divisions 10, 20, 30, &c. in the tangent line BT, and transfer these extents severally to the right line CS, then will that line be a line of secants.

8thly. Right lines drawn from A to the several divisions 10, 20, 30, &c. in the quadrant BD, will divide the radius CD into a line of semi-tangents.

9thly. Divide the quadrant AD into eight equal parts, and from A as a centre transfer these divisions severally into the line AD, then will AD be a line of Rhumbs, each division answering to 11° 15′ upon the line of chords. The use of this line is for protracting and measuring angles, according to the common division of the mariner's compass. If the radius AC be divided into 100 or 1000, &c. equal parts, and the lengths of the several sines, tangents, and secants, corresponding to the several arches of the quadrant, be measured thereby, and these numbers be set down in a table,* each in its proper column, you will by these means have a collection of numbers by which the several cases in trigonometry may be solved. Right lines graduated as above, being placed severally upon a ruler, form the instrument called the Plane Scale, (see Plate II. fig. 2.) by which the lines and angles of all triangles may be measured. All right lines, as the sides of plain triangles, &c. when they are considered simply as such without having any relation to a circle, are measured by scales of equal parts, one of which is subdivided equally into 10, and this serves as a common division to all the rest. In most scales an inch is taken for a common measure, and what an inch is divided into is generally set at the end of the scale. By any common scale of equal parts, divided in this manner, any number less than 100 may be readily taken; but if the number should consist of three places of figures, the value of the third figure cannot be exactly ascertained, and in this case it is better to use a diagonal scale, by which any number consisting of three places of figures, may be exactly found. The figure of this scale is given in Plate II. fig. 3: its construction is as follows.

Having prepared a ruler of convenient breadth for your scale, draw near the edges thereof two right lines, *af*, *cg*, parallel to each other; divide one of these lines as *af*, into equal parts, according to the size of your scale;† and

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* In table XXIV. is given the sine and co-sine to every minute of the quadrant, to five places of decimals.

† The length of one of these equal parts at the end of the scale to which this description refers is *ab* or *cd*. The length of one of the equal parts of the scale of the other end being the half of *ab*.

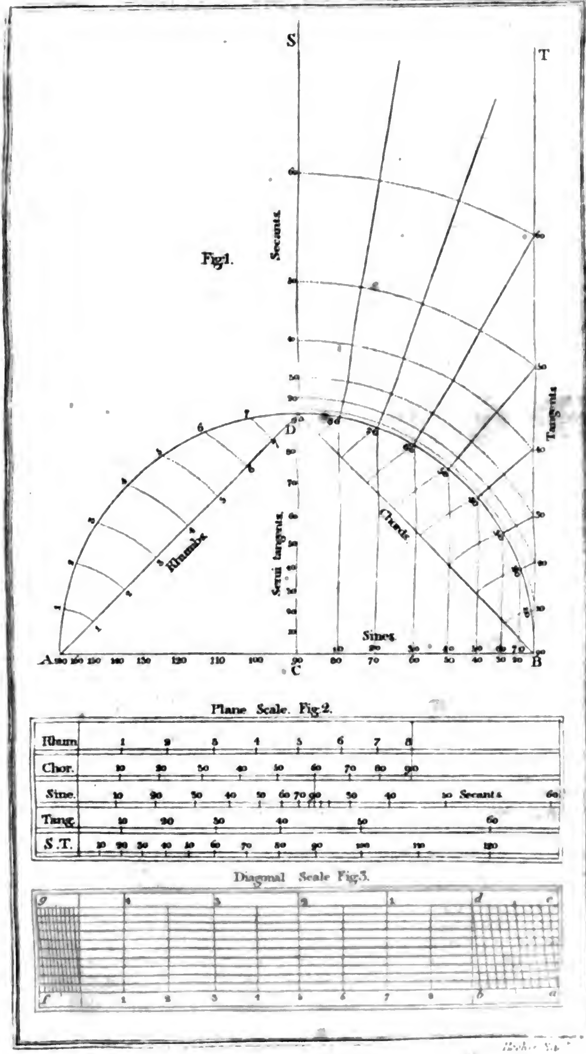
Fig.1.
S
T
Secants
Tangents
Semi tangents
Rhumbs
Chords
Sines
A
B
C
D
Plane Scale. Fig.2.
Rhum
Chor.
Sine.
Secants
Tang.
S.T.
Diagonal Scale Fig.3.

through each of these divisions draw right lines perpendicular to *af*, to meet *cg*, then divide the breadth into 10 equal parts, and through each of these divisions draw right lines parallel to *af* and *cg*; divide the lines *ab*, *cd*, into 10 equal parts, and from the point *a* to the first division in the line *cd*, draw a diagonal line; then parallel to that line, draw diagonal lines through all the other divisions, and the scale is complete. Then, if any number, consisting of three places of figures, as 256, be required from the larger scale *gd*, you must place one foot of the compasses on the figure 2 on the line *gd*, then the extent from 2 to the point *d* will represent 200. The second figure being 5, count five of the smaller divisions from *d* towards *e*, and the extent from 2 to that point will be 250. Move both points of the compasses downwards till they are on the sixth parallel line below *gd*, and open them a little till the one point rests on the vertical line drawn through 2, and the other on the diagonal line drawn through 5; the extent then in the compasses will represent 256. In the same way the quantities 25,6; 2,56; 0,256, &c. are measured.

Besides the lines already mentioned, there is another on the Plane Scale marked ML, which is joined to a line of chords, and shows how many miles of easting or westing correspond to a degree of longitude in every latitude.* These several lines are generally put on one side of a ruler, two feet long; and on the other side is laid down a scale of the logarithms of the sines, tangents, and numbers, which is commonly called Gunter's Scale, and as it is of general use, it requires a particular description.

GUNTER'S SCALE.

ON GUNTER'S SCALE are eight lines, viz.

1st. Sine Rhumbs, marked (SR) corresponding to the logarithms† of the natural sines of every point of the mariner's compass, numbered from the left hand towards the right, with 1, 2, 3, 4, 5, 6, 7, to 8, where is a brass pin. This line is also divided, where it can be done, into halves and quarters.

2d. Tangent rhumbs, marked (TR) correspond to the logarithms of the tangents of every point of the compass, and are numbered 1, 2, 3, to 4, at the right hand where there is a pin, and thence towards the left hand with 5, 6, 7; it is also divided, where it can be done, into halves and quarters.

3d. The line of numbers, marked (Num.) corresponds to the logarithms of numbers, and is marked thus; near the left hand it begins at 1, and towards the right hand are 2, 3, 4, 5, 6, 7, 8, 9; and 1 in the middle, at which is a brass pin, then 2, 3, 4, 5, 6, 7, 8, 9, and 10 at the end, where there is another pin. The values of these numbers and their intermediate divisions depend on the estimated values of the extreme numbers 1 and 10; and as this line is of great importance, a particular description of it will be given. The first 1 may be counted for 1, 10, 100, or 1000, &c. and then the next 2, will be 2, 20, 200, or 2000, &c. respectively. Again, the first 1 may be reckoned 1 tenth, 1 hundredth, or 1 thousandth part, &c. then the next will be 2 tenths, or 2 hundredths, or 2 thousandths parts, &c. so that if the first 1 be esteemed 1, the middle 1 will be 10; 2 to its right 20; 3, 30; 4, 40; and 10 at the end 100; again, if the first 1 is 10, the next 2 is 20, 3 is 30, and so on, making the middle 1, 100, the next 2 is 200, 3 is 300, 4 is 400, and 10 at the end is 1000. In like manner, if the first 1 be esteemed 1 tenth part, the next 2 will be 2

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* As it would confuse the adjoined figure to describe on it the line of longitudes, it is neglected, but the construction is as follows: divide the line CB into 60 equal parts (if it can be done) and through each point draw lines parallel to CD to intersect the arch BD: about B, as a centre, transfer the several points of intersection to the line BD, and then number it from D, towards B, from 0 to 60, and it will be the line of longitudes.

† The description and use of logarithms are given in page 29, et seq. The log-sines, tangents, &c. are marked on these scales by means of a line of equal parts, corresponding to the size of the scale.

tenth parts, and the middle 1 will be 1; the next 2, 2; and 10 at the end will be 10. Again, if the first 1 be counted 1 hundredth part, the next 2 hundredth parts, the middle 1 will be 10 hundredth parts, or one tenth part, and the next 2 two tenth parts, and 10 at the end will be but one whole number or integer.

As the figures are increased or diminished in their value, so in like manner must all the intermediate strokes or subdivisions be increased or diminished: that is, if the first 1 at the left hand be counted 1, then 2 (next following it) will be 2, and each subdivision between them will be 1 tenth part, and so all the way to the middle 1, which will be 10, the next 2, 20, and the longer strokes between 1 and 2 are to be counted from 1 thus, 11, 12, (where is a brass pin) then 13, 14, 15, sometimes a longer stroke than the rest, then 16, 17, 18, 19, 20, at the figure 2; and in the same manner the short strokes between the figures 2 and 3, 3 and 4, 4 and 5, &c. are to be reckoned as units. Again, if 1 at the left hand be 10, the figures between it and the middle 1 will be common tens; and the subdivisions between each figure will be units; from the middle 1 to 10 at the end, each figure will be so many hundreds; and between these figures each longer division will be 10. From this description it will be easy to find the divisions representing any given number, thus: Suppose the point representing the number 12, were required; take the division at the figure 1 in the middle, for the first figure of 12; then for the second figure count two tenths, or longer strokes to the right hand, and this will be the point representing 12, where the brass pin is.

Again, suppose the number 22 were required; the first figure 2 is to be found on the scale, and for the second figure 2, count 2 tenths onwards, and that is the point representing 22.

Again, suppose 1728 were required; for the first figure 1, I take the middle 1, for the second figure 7, count onwards as before, and that will be 1700. And as the remaining figures are 28 or nearly 30, I note the point which is nearly $\frac{3}{10}$, of the distance between the marks 7 and 8, and this will be the point representing 1728.

If the point representing 435 was required; from the 4 in the second interval count towards 5 on the right, three of the larger divisions and one of the smaller (this smaller division being midway between the marks 3 and 4) and that will be the division expressing 435. In a similar manner other numbers may be found.

All fractions found in this line must be decimals; and if they are not, they must be reduced into decimals, which is easily done by extending the compasses from the denominator to the numerator; that extent laid the same way, from 1 in the middle or right hand, will reach to the decimal required.

Example. Required the decimal fraction equal to $\frac{3}{4}$: Extend from 4 to 3; that extent will reach from 1 on the middle to ,75 towards the left hand. The like may be observed of any other vulgar fraction.

Multiplication is performed on this line, by extending from 1 to the multiplier: that extent will reach from the multiplicand to the product.

Suppose, for example, it were required to find the product of 16 multiplied by 4, extend from 1 to 4; that extent will reach from 16 to 64, the product required.

Division being the reverse of multiplication, therefore extend from the divisor to unity; that extent will reach from the dividend to the quotient.

Suppose 64 to be divided by 4; extend from 4 to 1, that extent will reach from 64 to 16, the quotient.

Questions in the Rule of Three are solved by this line as follows: Extend from the first term to the second, that extent will reach from the third term* to the fourth. And it ought to be particularly noted, that if you extend to the left, from the first number to the second, you must also extend to the left, from the third number to the fourth; and the contrary.

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* Or you may extend from the first to the third, for that extent will reach from the second to the fourth. This method must be adopted when using the lines of sines, tangents, &c. if the first and third terms are of the same name, and different from the second and fourth.

Example. If the diameter of a circle be 7 inches, and the circumference 22, what is the circumference of another circle, the diameter of which is 14 inches? Extend from 7 to 22, that extent will reach from 14 to 44 the same way.

The superficial content of any parallelogram is found by extending from 1 to the breadth; that extent will reach from the length to the superficial content.

Example. Suppose a plank or board, 15 inches broad and 27 feet long, the content of which is required: Extend from 1 to 1 foot 3 inches (or 1,25;) that extent will reach from 27 feet to 33,75 feet, the superficial content. Or extend from 12 inches to 15, &c.

The solid content of any bale, box, chest, &c. is found by extending from 1 to the breadth; that extent will reach from the depth to a fourth number, and the extent from 1 to that fourth number will reach from the length to the solid content.

Example 1st. What is the content of a square pillar, whose length is 21 feet 9 inches, and breadth 1 foot 3 inches? The extent from 1 to 1,25 will reach from 1,25 to 1,56, the content of one foot in length; again, the extent from 1 to 1,56 will reach from the length 21,75 to 33,9, or 34, the solid content in feet.

Example 2d. Suppose a square piece of timber, 1,25 feet broad, ,56 deep, and 36 long, be given to find the content: extend from 1 to 1,25; that extent will reach from ,56 to ,7; then extend from 1 to ,7; that extent will reach from 36 to 25,2 the solid content. In like manner may the contents of bales, &c. be found, which divided by 40 will give the tonnage.

4thly. The line of sines marked (Sin.) corresponding to the log-sines of the degrees of the quadrant, begins at the left hand, and is numbered to the right thus: 1, 2, 3, 4, 5, &c. to 10; then 20, 30, 40, &c. ending at 90 degrees, where is a brass centre pin, as there is at the right end of all the lines.

5thly. The line of versed sines, marked (V. S.) corresponding to the log versed sines of the degrees of the quadrant, begins at the right hand against 90° on the sines, and from thence is numbered towards the left hand thus: 10, 20, 30, 40, &c. ending at the left hand at about 169°; each of the subdivisions, from 10 to 30, is in general two degrees, from thence to 90 is single degrees, from thence to the end, each degree is divided into 15 minutes.

6thly. The line of tangents, marked (Tang.) corresponding to the log-tangents of the degrees of the quadrant, begins at the left hand, and is numbered towards the right thus: 1, 2, 3, &c. to 10, and so on 20, 30, 40, and 45, where is a brass pin under 90° on the sines; from thence it is numbered backwards, 50, 60, 70, 80, &c. to 89, ending at the left hand where it began at 1 degree. The subdivisions are nearly similar to those of the sines. When you have any extent in your compasses, to be set off from any number less than 45° on the line of tangents, towards the right, and it is found to reach beyond the mark of 45°, you must see how far it extends beyond that mark, and set it off from 45° towards the left, and see what degree it falls upon, which will be the number sought, which must exceed 45°; if, on the contrary, you are to set off such a distance to the right from a number greater than 45°, you must proceed as before, only remembering, that the answer must be less than 45°, and you must always consider the degrees above 45° as if they were marked on the continuation of the line to the right hand of 45°.

7thly. The line of the meridional parts, marked (Mer.) begins at the right hand, and is numbered thus; 10, 20, 30, &c. to the left hand, where it ends at 87 degrees. This line, with the line of equal parts, marked (E. P.) under it, are used together, and only in Mercator's Sailing. The upper line contains the degrees of the meridian, or latitude in a Mercator's chart, corresponding to the degrees of longitude on the lower line.

The use of this Scale in solving the usual problems of Trigonometry, Plane Sailing, Middle Latitude Sailing, and Mercator's Sailing, will be given in the course of this work; but it will be unnecessary to enter into an explanation of its use in calculating the common problems of Nautical Astronomy, as it is much more accurate to perform those calculations by logarithms.

ON THE SLIDING RULE.

THE Sliding Rule consists of a *fixed part* and a *slider*, and is of the same dimensions, and has the same lines marked on it as on a common Gunter or Plane Scale, which may be used with a pair of compasses in the same manner as those scales; and as a description of those lines has already been given, it will be unnecessary to repeat it here, it being sufficient to observe, that there are two lines of numbers, a line of log-sines and a line of log-tangents on the slider, and that it may be shifted so as to fix any face of it on either side of the fixed part of the scale, according to the nature of the question to be solved.

In solving any problem in Arithmetic, Trigonometry, Plane Sailing, &c. let the proposition be so stated that the first and third terms may be alike, and of course the second and fourth terms alike; then *bring the first term of the analogy on the fixed part, against the second term on the slider, and against the third term on the fixed part will be found the fourth term on the slider*;* or if necessary the first and third terms may be found on the slider, and the second and fourth on the fixed part. Multiplication and Division are performed by this rule, in considering unity as one of the terms of the analogy.

Thus, to perform multiplication, set 1 on the line of numbers of the fixed part against one of the factors on the line of numbers of the slider, then against the other factor on the fixed part will be found the product on the slider.

EXAMPLE. To find the product of 4 by 12 draw out the slider till 1 on the fixed part coincides with 4 on the slider, then opposite 12 on the fixed part will be found 48 on the slider.

To perform Division, set the divisor on the line of numbers of the fixed part against 1 on the slider, then against the dividend, on the fixed part, will be found the quotient on the slider.

EXAMPLE. To divide 48 by 4—set 4 on the fixed part against 1 on the slider, then against 48 on the fixed part will be found 12 on the slider.

EXAMPLES IN THE RULE OF THREE.

If a ship sail 25 miles in 4 hours, how many miles will she sail in 12 hours at the same rate?

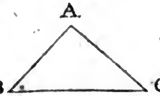
Bring 4 on the line of numbers of the fixed part against 25 on the line of numbers of the slider, then against 12 on the fixed part will be found 75 on the slider, which is the answer required.

EXAMPLE. If 3 pounds of sugar cost 21 cents, what will 27 pounds cost?

Bring 3 on the line of numbers of the fixed part, against 21 on the line of numbers of the slider, then against 27 on the fixed part, will be found 189 on the slider.

EXAMPLE IN TRIGONOMETRY.

In the oblique-angled triangle ABC, let there be given AB=56, AC=64, angle ABC=46° 30′ to find the other angles and the side BC.



In this case we have (*by art.* 58 *Geometry*) the following canons.——
AC (64) : sine < B (46° 30′) : : AB (56) : sine < C, and sine < B : AC : : sine < A : BC. Therefore, to work the first proposition by the sliding rule,

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* If the first and second terms are alike, instead of the first and third, you must bring the first term on the slider against the third on the fixed part, and against the second term on the slider, will be found the fourth term on the fixed part. Or, if necessary, the first and second terms may be found on the fixed part, and the third and fourth on the slider.

we must bring 64 on the line of numbers of the fixed part, against 46° 30′ on the line of sines of the slider, then against 56 on the former will be 39° 24′ on the latter, which will be the angle C. The sum of the angles B and C being subtracted from 180° leaves the angle A=94° 6′. Then, by the second canon, bring the angle B=46° 30′ on the line of sines of the slider against AC=64 on the line of numbers of the fixed part, then against the angle A=94° 6′ (or its supplement 85° 54′) on the slider will be found the side BC=88 on the fixed part.

In a similar manner may the other propositions in trigonometry be solved.

From what has been said, it will be easy to work all the problems in Plane, Middle Latitude, and Mercator's Sailing, as in the three following examples, which the learner may pass over until he can solve the same problems by the Scale. If any one wishes to know the use of the sliding rule in problems of Spherical Trigonometry, he may consult the treatises written expressly on that subject: but it may be observed, that in such calculations the sliding rule is rather an object of curiosity than of real use, as it is much more accurate to make use of logarithms.

Example 1. Given the course sailed 1 point, and the distance 85 miles—required the difference of Latitude and Departure?

By Case 1st of Plane Sailing, we have these canons:

Radius (8 points): Distance (85) :: Sine. Co. Course (7 points): Diff. Lat.; and Radius (8 points): Distance (85) :: Sine Course (1 point): Departure.

Hence we must bring the radius 8 points on the fixed part of the Sine Rhumbs against 85 on the line of numbers on the slider, then against 7 points on the sine rhumbs will be found the diff. of lat. 83⅓ on the slider, and against one point will be found the departure 16⅓ miles.

If the course is given in degrees, you must use the line marked *Sin.*

Example 2. Given the diff. of lat. 40 miles, and departure 30 miles—required the course and distance?

By case 6, of Plane Sailing, we have this canon for the course:—

Diff. Lat. (40): Radius 45° :: Departure (30): Tang. Course.

Hence we must bring 40 on the line of numbers of the slider against 45° on the line of tangents on the fixed part, then against 30 on the slider will be found the course 37° nearly.

Again, the canon for the distance gives:

Sine Course (37°): Departure (30) :: Radius (90°): Distance.

Hence we must bring 37° on the line of sines of the fixed part against 30 on the line of numbers on the slider, then against 90° on the line of sines of the fixed part will be found the distance 50 on the slider.

Example 3. Given the Middle Lat. 40° and the departure 30 miles—required the Diff. of Long.?

By case 6, of Middle Latitude Sailing, we have this canon:—

Sine Comp. Mid. Lat. (50°): Departure (30) :: Radius (90°): Diff. Long.

Hence by bringing 50° on the line of sines of the fixed part against 30 on the line of numbers on the slider, then against 90° on the fixed part, we shall find 39 on the slider, which will be the difference of longitude required.

DESCRIPTION AND USE OF THE SECTOR.

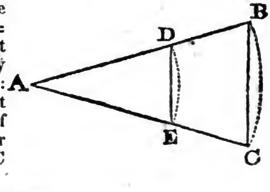
THIS instrument consists of two rules or legs, moveable round an axis or joint, as a centre, having several scales drawn on the faces, some single, others double; the single scales are like those upon a common Gunter's Scale; the double scales are those which proceed from the centre, each being laid twice on the same face of the instrument, viz. once on each leg. From these scales, dimensions or distances are to be taken, when the legs of the instrument are set in an angular position.

The single scales being used exactly like those on the common Gunter's Scale, it is unnecessary to notice them particularly; we shall therefore only enumerate a few of the uses of the double scale, the number of which is seven, viz. the scale of Lines, marked Lin. or L. the scale of chords, marked Cho. or C. the scale of Sines, marked Sin. or S. the scale of Tangents to 45°, and another scale of tangents from 45° to about 76°, both of which are marked Tan. or T. the scale of Secants, marked Sec. or S. and the scale of Polygons, marked Pol.

The scale of lines, chords, sines, and tangents, under 45°, are all of the same radius, beginning at the centre of the instrument, and terminating near the other extremity of each leg, viz. the lines at the division 10, the chords at 60°, the sines at 90°, and the tangents at 45°; the remainder of the tangents, or those above 45°, are on other scales, beginning at a quarter of the length of the former, counted from the centre, where they are marked with 45°, and extend to about 76 degrees. The secants also begin at the same distance from the centre, where they are marked with 0, and are from thence continued to 75°: The scales of polygons are set near the inner edge of the legs, and where these scales begin, they are marked with 4, and from thence are numbered backward or towards the centre, to 12.

In describing the use of the sector, the terms *lateral distance* and *transverse distance* often occur. By the former is meant the distance taken with the compasses on one of the scales only, beginning at the centre of the sector; and by the latter, the distance taken between any two corresponding divisions of the scales of the same name, the legs of the sector being in an angular position.

The use of the sector depends upon the porportionability of the corresponding sides of similar triangles, *(demonstrated in art. 53, Geometry.)* For if in the triangle ABC we take AB=AC and AD=AE, and draw DE, BC, it is evident that DE and BC will be parallel; therefore by the above-mentioned proposition AB : BC :: AD : DE; so that whatever part AD is of AB, the same part DE will be of BC; hence, if DE be the chord, sine, or tangent of any arch to the radius AD, BC will be the same to the radius AB.



Use of the line of Lines.

The line of lines is useful to divide a given line into any number of equal parts, or in any proportion, or to find 3d and 4th proportionals, or mean proportionals, or to increase a given line in any proportion.

Example 1. To divide a given line into any number of equal parts, as suppose 9: make the length of the given line a transverse distance to 9 and 9, the number of parts proposed; then will the transverse distance of 1 and 1 be one of the parts, or the ninth part of the whole; and the transverse distance of 2 and 2 will be 2 of the equal parts or $\frac{2}{9}$ of the whole line, &c.

Example 2. If a ship sails 52 miles in 8 hours, how much would she sail in 3 hours at the same rate?

Take 52 in your compasses as a transverse distance, and set it off from 8 to 8, then the transverse distance 3 and 3 being measured laterally, will be found equal to 19 and a half, which is the number of miles required.

Example 3. Having a chart constructed upon a scale of 6 miles to an inch, it is required to open the sector, so that a corresponding scale may be taken from the line of lines?

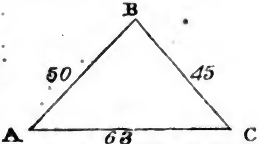
Make the transverse distance 6 and 6, equal to 1 inch, and this position of the sector will produce the given scale.

Example 4. It is required to reduce a scale of 6 inches to a degree, to another of 3 inches to a degree?

Make the transverse distance 6 and 6, equal to the lateral distance 3 and 3: then set off any distance from the chart laterally, and the corresponding transverse distance will be the reduced distance required.

Example 5. One side of any triangle being given, of any length, to measure the other two sides on the same scale.

Suppose the side AB of the triangle ABC measures 50, what are the measures of the other two sides?



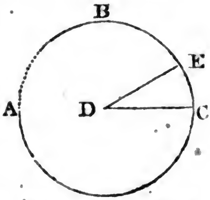
Take AB in your compasses, and apply it transversely to 50 and 50; to this opening of the sector apply the distance AC in your compasses to the same number on both sides of the rule transversely; and where the two points fall will be the measure on the line of lines of the distance required; the distance AC will fall against 63, 63, and BC against 45, 45, on the line of lines.

Use of the line of Chords on the Sector.

The line of chords upon the sector is very useful for protracting any angle, when the paper is so small that an arch cannot be drawn upon it with the radius of a common line of chords.

Suppose it was required to set off an arch of 30°, from the point C of the small circle ABC.

Take the radius DC in your compasses, and set it off transversely from 60° to 60° on the chords, then take the transverse extent from 30° to 30° on the chords; and place one foot of the compasses in C, the other will reach to E, and CE will be the arch required. And by the converse operation any angle or arch may be measured, viz. with any radius describe an arch about the angular point; set that radius transversely from 60° to 60°; then take the distance of the arch, intercepted between the two legs, and apply it transversely to the chords, which will show the degrees of the given angle.



Note. When the angle to be protracted exceeds 60°, you must lay off 60°, and then the remaining part; or if it be above 120°, lay off 60° twice, and then the remaining part. And in a similar manner any arch above 60° may be measured.

Uses of the lines of Sines, Tangents, and Secants.

By the several lines disposed on the sector, we have scales of several radii, so that,

1st. Having a length or radius given, not exceeding the length of the sector when opened, we can find the chord, sine, &c. of an arch to that radius; thus, suppose the chord, sine, or tangent of 20 degrees to a radius of 2 inches be required. Make 2 inches the transverse opening to 60° and 60° on the chords: then will the same extent reach from 45° to 45° on the tangents, and

from 90° to 90° on the sines; so that to whatever radius the line of chords is set, to the same are all the others set also. In this disposition, therefore, if the transverse distance between 20° and 20° on the chords be taken with the compass, it will give the chord of 20 degrees; and if the transverse of 20° and 20° be in like manner taken on the sines, it will be the sine of 20 degrees; and lastly, if the transverse distance of 20° and 20° be taken on the tangents, it will be the tangent of 20 degrees to the same radius of two inches.

2dly. If the chord or tangent of 70° were required. For the chord you must first set off the chord of 60° (or the radius) upon the arch, and then set off the chord of 10°. To find the tangent of 70 degrees, to the same radius, the scale of upper tangents must be used, the under one only reaching to 45°; making therefore 2 inches the transverse distance to 45° and 45° at the beginning of that scale, the extent between 70° and 70° on the same will be the tangent of 70 degrees to 2 inches radius.

3dly. To find the secant of any arch; make the given radius the transverse distance between 0 and 0 on the secants; then will the transverse distance of 20° and 20°, or 70° and 70°, give the secant of 20° or 70° respectively.

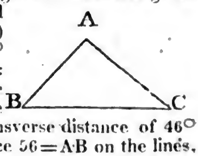
4thly. If the radius and any line representing a sine, tangent, or secant, be given, the degrees corresponding to that line may be found by setting the sector to the given radius, according as a sine, tangent, or secant is concerned; then taking the given line between the compasses, and applying the two feet transversely to the proper scale, and sliding the feet along till they both rest on like divisions on both legs; then the divisions will show the degrees and parts corresponding to the given line.

Use of the line of Polygons.

The use of this line is to inscribe a regular polygon in a circle. For example, let it be required to inscribe an octagon in a circle. Open the sector till the transverse distance 6 and 6 be equal to the radius of the circle; then will the transverse distance of 8 and 8 be the side of the inscribed polygon.

Use of the sector in Trigonometry.

All proportions in trigonometry are easily worked by the double lines on the sector; observing that the sides of triangles are taken off the line of lines, and the angles are taken off the sines, tangents, or secants, according to the nature of the proportion. Thus, if in the triangle ABC we have given AB=56, AC=64, and the angle ABC=46° 30′ to find the rest. In this case we have (*by art.* 58, *Geometry*) the following proportions, as AC (64) : sine < B (46° 30′) :: AB (56) : sine < C, and as sine B : AC :: sine A : BC. Therefore to work these proportions by the sector, take the lateral distance 64=AC from the line of lines, and open the sector to make this a transverse distance of 46° 30′=< B on the sines; then take the lateral distance 56=AB on the lines, and apply it transversely on the sines, which will give 39° 24′=< C. Hence the sum of the angles B and C is 85° 54′, which taken from 180°, leave the angle A=94° 6′. Then to work this second proportion, the sector being set at the same opening as before, take the transverse distance of 94° 6′=the angle A on the sines, or, which is the same thing, the transverse distance of its supplement 85° 54′; then this applied laterally to the lines, gives the sought side BC=88. In the same manner we might solve any problem in trigonometry, where the tangents and secants occur, by only measuring the transverse distances on the tangents or secants, instead of measuring them on the sines, as in the preceding example. All the problems that occur in Nautical Astronomy may be solved by the sector, but as the calculation by logarithms is much more accurate, it will be useless to enter into a further detail on this subject.



LOGARITHMS.

IN order to abbreviate the tedious operations of multiplication and division with large numbers, a series of numbers, called logarithms, were invented by Lord Napier, Baron of Marchinston in Scotland, and published in Edinburgh in 1614; by means of which the operation of multiplication may be performed by addition, and division by subtraction; numbers may be involved to any power by simple multiplication, and the root of any power extracted by simple division.

In Table XXVI. are given the logarithms of all numbers from 1 to 9999; to each one ought to be prefixed an index, with a period or dot to separate it from the other part, as in decimal fractions; the numbers from 1 to 100 are published in that table with their indices; but from 100 to 9999 the index is left out for the sake of brevity, but it may be supplied by this general rule, viz. *the index of the logarithm of any integer, or mixed number, is always one less than the number of integer places in the natural number.* Thus the index of the logarithm of any number (integer or mixed) between 10 and 100 is 1, from 100 to 1000 it is 2, from 1000 to 10000 is 3, &c. the method of finding the logarithms from this table will be evident from the following examples.

To find the logarithms of any number less than 100.

RULE. Enter the first page of the table, and opposite the given number will be found the logarithm with its index prefixed.

Thus, opposite 71 is 1.85126, which is its logarithm.

To find the logarithm of any number between 100 *and* 1000.

RULE. Find the given number in the left hand column of the table of logarithms, and immediately under 0 in the next column, is a number, to which must be prefixed the number 2 as an index (because the number consists of three places of figures) and you will have the sought logarithm.

Thus, if the logarithm of 649 was required; this number being found in the left hand column, against it in the column marked 0 at the top (or bottom) is found 81224, to which prefixing the index 2, we have the logarithm of 649=2.81224.

To find the logarithm of any number between 1000 *and* 10000.

RULE. Find the three left hand figures of the given number, in the left hand column of the table of logarithms, opposite to which, in the column that is marked at the top (or bottom) with the fourth figure, is to be found the sought logarithm; to which must be prefixed the index 3, because the number contains 4 places of figures.

Thus, if the logarithm of 6495 was required; opposite to 649, and in the column marked 5 at the top (or bottom) is 81258, to which prefix the index 3 and we have the sought logarithm 3.81258.

To find the logarithm of any number above 10000.

RULE. Find the three first figures of the given number, in the left hand column of the table, and the fourth figure at the top or bottom, and take out the corresponding number as in the preceding rule; take also the difference between this logarithm and the next greater, and multiply it by the given number exclusive of the four first figures, cross off at the right hand of the product as many figures as you had figures of the given number to multiply by; then add the remaining left hand figures of this product to the logarithm taken from the table, and to the sum prefix an index equal to one less than the number of integer figures in the given number, and you will have the sought logarithm.

Thus, if the logarithm of 64957 was required: opposite to 649 and under 5 is 81258, the difference between this and the next greater number 81265 is 7, this multiplied by 7 (the last figure of the given number) gives 49, crossing off the right hand figure leaves 4.9 or 5 to be added to 81258, which makes 81263, to this prefixing the index 4, we have the sought logarithm 4.81263.

Again, if the logarithm of 6495738 was required: the logarithm corresponding to 649 at the left, and 5 at the top, is as in the last example 81258,

the difference between this and the next greater is 7, which multiplied by 738 (which is equal to the given number excluding the four first figures) gives 5166, crossing off the three right hand figures of this product (because the number 738 consists of three figures) we have the correction 5 to be added to 81258; and the index to be prefixed is 6 because the given number consists of 7 places of figures, therefore the sought logarithm is 6.81263.

To find the logarithm of any mixed decimal number.

RULE. Find the logarithm of the number as if it was an integer by the last rule, to which prefix the index of the integer part of the given number.

Thus, if the logarithm of the mixed decimal 649.5738 was required;—find the logarithm of 6495738 without noticing the decimal point; this, in the last example, was found to be 81263, to this we must prefix the index 2, corresponding to the integer part 649; the logarithm sought will therefore be 2.81263.

To find the logarithm of any decimal fraction less than unity.

The index of the logarithm of any number less than unity is negative, but to avoid the mixture of positive and negative quantities, it is common to borrow 10 or 100 in the index, which must afterwards be neglected in summing them with other indices; thus instead of writing the index — 1, it is generally written + 9 or + 99; but in general it is sufficient to borrow 10 in the index, *and it is what we shall do in the rest of this work.* In this way we may find the logarithm of any decimal fraction by the following rules.

RULE. Find the logarithm of a fraction as if it was a whole number;—see how many ciphers precede the first figure of the decimal fraction, subtract that number from 9 and the remainder will be the index of the given fraction.

Thus the log. of 0,0391 is 8.59218; the log. of 0,25 is 9.39794; the log. of 0,0000025 is 4.39794, &c.

To find the logarithm of a vulgar fraction.

RULE. Subtract the logarithm of the denominator from the logarithm of the numerator (borrowing 10 in the index when the denominator is the greatest) the remainder will be the logarithm of the fraction sought.

EXAMPLE I.		EXAMPLE II.	
Required the log. of $\frac{3}{8}$?		Required the log. of $3\frac{1}{4}$ or $\frac{13}{4}$?	
From log. of 3	0.47712	From log. of 13	1.11394
Take log. of 8	0.90309	Take log. of 4	0.60206
Rem. log. $\frac{3}{8}$ or ,375	9.57403	Rem. log. of $3\frac{1}{4}$ or 3,25	0.51188

To find the number corresponding to any logarithm.

RULE. In the column marked 0 at the top (and bottom) of the table, seek for the next less logarithm, neglecting the index; note the number against it. and carry your eye along that line until you find the nearest less logarithm to the given one, and you will have the fourth figure of the given number at the top, which is to be placed to the right of the three other figures; if you wish for greater accuracy, you must take the difference between this tabular logarithm and the next greater, also the difference between that least tabular logarithm and the given one; to the latter difference annex 2 or more ciphers at the right hand, and divide it by the former difference, and place the quotient* to the right hand of the four figures already found; and you will have the number sought expressed in a mixed decimal, the integer part of which will consist of a number of figures (at the left hand) equal to the index of the logarithm increased by unity.†

Thus, if the number corresponding to the logarithm 1.52634 was required; I look for 52634 in the column marked 0 at the top or bottom, and find it standing opposite to 336; now the index being 1, the sought number must consist of two integer places, therefore it is 33,6.

* This quotient must consist of as many places of figures as there were ciphers annexed, conformable to the rules of the division of decimals. Thus, if the divisor was 40, and the number to which two ciphers were annexed was 2, making 2,00, the quotient must not be estimated as 5, but as 05, and then two figures must be placed to the right of the four figures before found.

† If the index corresponds to a fraction less than unity, you must place as many ciphers to the left of that number as are equal to the Index subtracted from 9, the decimal point being placed to the left of these ciphers; in this manner you will obtain the sought number.

If the given logarithm was 2.32838; I find that 32838 stands in the column marked 0 at the top or bottom, directly opposite to 213 which is the number sought, because the index being 2, the number must consist of 3 places of figures.

If the number corresponding to the logarithm 2.57345 was required; I look in the column 0, and find in it, against the number 374, the logarithm 57287, and guiding my eye along that line, I find the given logarithm 57345 in the column marked 5; therefore the mixed number sought is 3745, and since the index is 2, the integer part must consist of 3 places, therefore the number sought is 374,5. If the index had been 1, the number would have been 37,45; and if the index had been 0, the number would have been 3,745. If the index had been 8 corresponding to a number less than unity, the answer would have been 0,03745, &c.

Again, if the number corresponding to the logarithm 5,57811 was required; I look in the column 0, and find in it against 378, and under 5, the logarithm 57807, the difference between this and the next greater logarithm 57818 being 11, and the difference between 57807 and the given number 57811 being 4, to this 4 I affix two ciphers, which make 400, and divide it by 11, the quotient is 36 nearly; this number connected with the former four figures make 378536, which is the number required, since the index being 5 the number must consist of six places of figures.

MULTIPLICATION BY LOGARITHMS.

Rule. Add the logarithms of the two numbers to be multiplied, and the sum will be the logarithm of their product.

EXAMPLE I.

Multiply 25 by 35.

25 log.	1.39794
35 log.	1.54407
Product 875 log.	2.94201

EXAMPLE II.

Multiply 22,4 by 1,8.

22,4 log.	1.35025
1,8 log.	0.25527
Product 40,32 log.	1.60552

EXAMPLE III.

Multiply 3,26 by 0,0025.

3,26 log.	0.51322
0,0025 log.	7.39794
Product 0,00815 log.	7.91116

EXAMPLE IV.

Multiply 0,25 by 0,003.

0,25 log.	9.39794
0,003 log.	7.47712
Product 0,00075 log.	6.87506

In the last example the sum of the two indices is 16, but since 10 was borrowed in each number, I have neglected 10 in the sum, and the remainder 6 being less than the other 10, is evidently the index of the logarithm of a fraction less than unity.

DIVISION BY LOGARITHMS.

Rule. From the logarithm of the dividend subtract the logarithm of the divisor, the remainder will be the logarithm of the quotient.

EXAMPLE I.

Divide 875 by 25.

875 log.	2.94201
25 log.	1.39794
Quotient 35 log.	1.54407

EXAMPLE II.

Divide 40,32 by 22,4.

40,32 log.	1.60552
22,4 log.	1.35025
Quotient 1,8 log.	0.25527

EXAMPLE III.

Divide 0,00815 by 0,0025.

0,00815 log.	7.91116
0,0025 log.	7.39794
Quotient 3,26 log.	0,51322

EXAMPLE IV.

Divide 0,00075 by 0,025.

0,00075 log.	6.87506
0,025 log.	8.39794
Quotient 0,03 log.	8.47712

In Example III. both the divisor and dividend are fractions less than unity, and the divisor is the least, consequently the quotient is greater than unity. In Example IV. both fractions are less than unity, and since the divisor is the greatest, its logarithm is greater than that of the dividend; for that reason it was necessary to borrow 10 in the index previous to making the subtraction, hence the quotient is less than unity.

INVOLUTION BY LOGARITHMS.

Rule. Multiply the logarithm of the number given, by the index of the power to which the quantity is to be raised, the product will be the logarithm of the power sought. But in raising the powers of any decimal fraction it must be observed, that the first significant figure of the power must be put as many places below the place of units as the index of its logarithm wants of 10 multiplied by the index of the power.

EXAMPLE I.

Required the square of 18?

18 log.	1.25527
	2
Answer 324 log.	2.51054

EXAMPLE II.

Required the cube of 13?

13 log.	1.11394
	3
Answer 2197 log.	3.34182

EXAMPLE III.

Required the square of 6,4?

6,4 log.	0.80618
	2
Answer 40,96 log.	1.61236

EXAMPLE IV.

Required the cube of 0,25?

0,25 log.	9.39794
	3
Answer 0,015625.	28.19382

In the last example the index 28 wants 2 of 30 (the product of 10 by the power 3) therefore the first significant figure of the answer, viz. 1, is placed two figures distant from the place of units.

EVOLUTION BY LOGARITHMS.

Rule. Divide the logarithm of the number by the index of the power, the quotient will be the logarithm of the root sought. But if the power whose root is to be extracted is a decimal fraction less than unity, prefix to the index of its logarithm a figure less by one than the index of the power,* and divide the whole by the index of the power, the quotient will be the logarithm of the root sought.

EXAMPLE I.

What is the square root of 324?

324 log.	2)2.51055
Answer 18 log.	1.25527

EXAMPLE II.

Required the cube root of 2197?

2197 log.	3)3.34183
Answer 13	log. 1.11394

EXAMPLE III.

Required the square root of 40,96?

40,96 log.	2)1.61236
Answer 6,4	log. 0.80618

EXAMPLE IV.

Required the cube root of 0,015625?

0,015625 log.	8.19382
Prefix 2 to the index	3)28.19382
Answer 0,25	log. 9.39794

TO WORK THE RULE OF THREE BY LOGARITHMS.

When three numbers are given to find a fourth proportional in arithmetic, we make a statement and say, as the first number is to the second so is the third to the fourth; and by multiplying the second and third together, and dividing the product by the first, we obtain the fourth number sought. To obtain the same result by logarithms, we must *add the logarithms of the second and third numbers together, and from the sum subtract the logarithm of the first number, the remainder will be the logarithm of the sought fourth number.*

EXAMPLE I.

If 6 yards of cloth cost 5 dollars, what will 20 yards cost?

As 6	log. 0.77815
Is to 5	log. 0.69897
So is 20	log. 1.30103
Sum of 2d. and 3d.	2.00000
Subtract first	0.77815
To 16.67	log. 1.22185

The answer therefore is 16 dollars and 67-100ths or 16 dollars and 67 cents.

EXAMPLE II.

If a ship sails 20 miles in 7 hours, how much will she sail in 21 hours at the same rate?

As 7	log. 0.84510
Is to 20	log. 1.30103
So is 21	log. 1.32222
Sum of 2d. and 3d.	2.62325
Subtract the first	0.84510
To 60	log. 1.77815
The answer is	60 miles.

* In this rule it is supposed that 10 was borrowed in finding the index of the decimal according to the rule page 30.

To calculate COMPOUND INTEREST *by Logarithms.*

To 100 dollars add its interest for one year; find the logarithm of this sum and reject 2 in the index, then multiply it by the number of years and parts of a year, for which the interest is to be calculated; to the product add the logarithm of the sum put at interest; the sum of these two logarithms will be the logarithm of the amount of the given sum for the given time.

EXAMPLE.

Required the amount of the principal and interest of 355 dollars, let at 6 per cent. compound interest for 7 years?

Adding 6 to 100 gives 106, whose logarithm, rejecting 2 in the index, is		0.02531
Multiplied by		7
Product		0.17717
Principal 355 dollars	log.	2.55023
Sum gives the log. of 533,83	log.	2.72740

Therefore the amount of principal and interest is 533 dollars and 83 cents.

To find the Logarithm-sine, Tangent, or Secant, corresponding to any number of Degrees and Minutes, by Table XXVII.

The given number of degrees must be found at the bottom of the page when between 45° and 135°, otherwise at the top, the minutes being found in the column marked M, which stands on the side of the page on which the degrees are marked; thus, if the degrees are less than 45, the minutes are to be found in the left hand column, &c. and it must be noted that if the degrees are found at the top, the names of hour, sine, co-sine, tangent, &c. must also be found at the top; and if the degrees are found at the bottom, the names sine, co-sine, &c. must also be found at the bottom. Then opposite to the number of the minutes will be found the log-sine, log-secant, &c. in the column marked sine, secant, &c. respectively.

EXAMPLE I.

Required the log. sine of 28° 37′?

Find 28° at the top of the page, directly below which, in the left hand column, find 37′; against which in the column marked sine is 9.68029, the log. sine of the given number of degrees; and in the same manner the tangents, &c. are found.

EXAMPLE II.

Required the log. secant of 126° 20′?

Find 126° at the bottom of the page, directly above which, in the left hand column, find 20′; against which, in the column marked secant, is 10.22732 required.

To find the Logarithm-sine, Co-sine, &c. for Degrees, Minutes, and Seconds, by Table XXVII.

Find the numbers corresponding to the even minutes next above and below the given degrees and minutes, and take their difference; then say, as 60″ is to the number of seconds in the proposed number, so is that difference to a correction to be applied to the number corresponding to the least number of degrees and minutes; additive if it is the least of the two numbers taken from the table, otherwise subtractive.

EXAMPLE I.

Required the log. sine of 24° 16′ 48″?

Sine of 24° 16′	9.61382
Sine of 24 17	9.61411
Diff.	29

Then, as 60″ : 48″ :: 29 : 23, which, added to the number corresponding to 24° 16′, gives 9.61405 the log. sine of 24° 16′ 48″.

EXAMPLE II.

Required the log. secant of 105° 20′ 16″?

Secant of 105.20 log.	10.57768
105.21	10.57722
Diff.	46

Then as 60″ : 16″ :: 46 : 12, which, subtracted from the number corresponding to 105° 20′, gives 10.57756, the log. sec. of 105° 20′ 16″.

If the given seconds be $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, or $\frac{1}{6}$, or any other even parts of a minute, the like parts may be taken of the difference of the logarithms, and added or subtracted as above, which may be frequently done by inspection.

To find the Degrees, Minutes, and Seconds, corresponding to any given Logarithm-sine, Co-sine, &c. by Table XXVII.

Find the two nearest numbers to the given logarithm-sine, co-sine, &c. in the column marked sine, co-sine, &c. respectively, one being greater and the other less, and take their difference; take also the difference between the given logarithm and the logarithm corresponding to the least number of degrees and minutes: then say, as the first found difference is to the second found difference, so is 60″ to a number of seconds to be annexed to the smallest number of degrees and minutes before found.

EXAMPLE I.

Find the degrees, minutes, and seconds (less than 90°) corresponding to the log. sine 9.61405.

Next less log. 24° 16′	9.61382	Log. of least numb. 24° 16′ is	9.61382
Greater 24 17	9.61411	Given log.	9.61405
	29		23

Then say, as 29 : 23 :: 60″ : 48″ which annexed to 24° 16′ give 24° 16′ 48″ answering to log. sine 9.61405. Subtracting 24° 16′ 48″ from 180°, there remains 155° 43′ 12″, the log. sine of which is also 9.61405.

EXAMPLE II.

Find the degrees, minutes, and seconds (above 90°) corresponding to the log. secant 10.56703.

Secant 105° 43′ log.	10.56722	Log. of the least numb. 105° 43′	10.56722
Secant 105 44	10.56677	Given log.	10.56703
	45		19

Then as 45 is to 19, so is 60″ to 25″, which annexed to 105° 43′, gives 105° 43′ 25″, the degrees, minutes, and seconds required.

To find the Arithmetical Complement of any Logarithm.

The arithmetical complement of any logarithm, is what it wants of 10,00000 and is used to avoid subtraction. For when working any proportion by logarithms, you may add the arithmetical complement of the logarithm of the first term, instead of subtracting the logarithm itself, observing to neglect 10 in the index of the sum of the logarithms. The arithmetical complement of any logarithm is thus found:—Begin at the index, and *write down what each figure wants of* 9, *except the last significant figure, which take from* 10*.

EXAMPLE.

Required the arithmetical complement of 9.62595?

For the first figure 9, write 0; for 6, 3; for 2, 7; for 5, 4; for 9, 0; and for the last figure 5, write 5; thus the arithmetical complement is 0,37405.

In the same manner the arithmetical complement of 1.86563 is 8.13437, the ar. co. of 10.33133 is 9.66867, and the ar. co. of 1.22800 is 8.77200. To illustrate the method of using the arithmetical complement of any logarithm, I shall here calculate the examples as given in page 32.

	EXAMPLE I.			EXAMPLE II.	
As 6	log. ar. co.	9.22185	As 7	log. ar. co.	9.15490
Is to 5	log.	0.69897	Is to 20	log.	1.30103
So is 20	log.	1.30103	So is 21	log.	1.32222
To 16,67	log.	1.22185	To 60	log.	1.77815

* When the index of the given logarithm is greater than 10, as in some of the numbers of Table XXVII. the left hand figure of it must be neglected; and when there are any ciphers to the right hand of the last significant figure, you may place the same number of ciphers to the right hand of the other figures of the arithmetical complement.

PLANE TRIGONOMETRY.

PLANE TRIGONOMETRY is the science which shows how to find the measures of the sides and angles of plane triangles, some of them being already known. It is divided into two parts, right-angled and oblique-angled: in the former case, one of the angles is a right angle or 90°; in the latter they are all oblique.

In every plane triangle there are six parts, viz. three sides and three angles; any three of which being given (except the three angles) the other three may be found by various methods, viz. by Gunter's Scale, by the sliding rule, by the sector, by geometrical construction, or by arithmetical calculation. We shall explain each of these methods;* but the latter is by far the most accurate; it is performed by the help of a few theorems, and a trigonometrical canon, exhibiting the natural or the logarithmic sines, tangents, and secants, to every degree and minute of the quadrant.† The theorems alluded to are the following:

THEOREM I.

In any right angled triangle, if the hypotenuse be made radius, one side will be the sine of the opposite angle, and the other its co-sine; but if either of the legs be made radius, the other leg will be the tangent of the opposite angle, and the hypotenuse will be the secant of the same angle.

Fig. 1

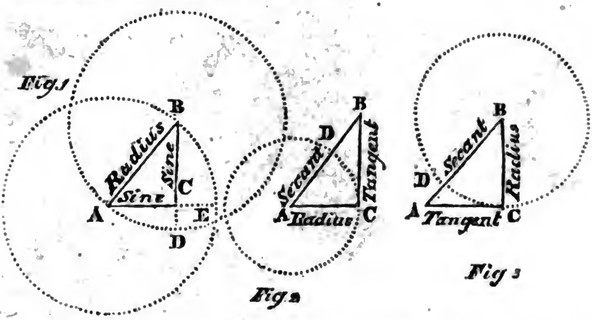


Fig. 2

Fig. 3

1st. If in the right-angled plane triangle ACB (fig. 1) we make the hypotenuse AB radius, and upon the centre A describe the arch BE, to meet AC produced in E; then it is evident that BC is the sine of the arch BE (or the sine of the angle BAC) and that AC is the co-sine of the same angle: and if the arch AD be described about the centre B, AC will be the sine of the angle ABC, and BC its co-sine.

2dly. If the leg AC (fig. 2) be made radius, and the arch CD be described about the centre A; CB will be the tangent of that arch, or the tangent of the angle CAB; and AB will be its secant.

3dly. If the leg BC (fig. 3.) be made radius, and the arch CD be described about the centre B; CA will be the tangent of that arch, or the tangent of the angle B; and AB will be its secant.

Now it has been already demonstrated *(in art. 55. Geom.)* that the sine, tang. sec. &c. of any arch in one circle, is to the sine, tang. sec. &c. of a similar arch in another circle as the radius of the former circle to the radius of the latter. And since in any right-angled triangle there are given either two sides, or the angles and one side, to find the rest; we may, if we wish to find

* It will not be necessary to add any further description of the uses of the sector or sliding rule, for what we have already given will be sufficient for any one, tolerably well versed in the use of Gunter's Scale.
† See Tables XXIV. and XXVII.

a side, make any side radius; then say, as the tabular number of the same name as the given side is to the given side of the triangle, so is the tabular number of the same name as the required side, to the required side of the triangle. If we wish to find an angle, one of the given sides must be made radius; then say, as the side of the triangle made radius, is to the tabular radius, so is the other given side to the tabular sine, tangent, secant, &c. by it represented; which being sought for in the table of sines, &c. will correspond to the degrees and minutes of the required angle.

THEOREM II.

In all plane triangles, the sides are in direct proportion to the sines of their opposite angles (by art. 58, Geom.)

Hence, to find a side, we must say, as the sine of an angle is to its opposite side, so is the sine of either of the other angles to the side opposite thereto. But if we wish to find an angle, we must say, as any given side is to the sine of its opposite angle, so is either of the other sides to the sine of its opposite angle.

THEOREM III.

In every plane triangle, it will be, as the sum of any two sides is to their difference, so is the tangent of half the sum of the two opposite angles to the tangent of half their difference (by art. 59, Geom.)

THEOREM IV.

As the base of any plane triangle is to the sum of the two sides, so is the difference of the two sides to twice the distance of a perpendicular (let fall upon the base from the opposite angle) from the middle of the base (by art. 60, Geom.)

THEOREM V.

In any plane triangle, as the rectangle contained by any two sides including a sought angle, is to the rectangle contained by the half sum of the sides and the half sum decreased by the other side, so is the square of radius to the square of the co-sine of half the sought angle (by art. 61, Geom.)

[In addition to these theorems, it will not be amiss for the learner to recall to mind the following articles, most of which have been already demonstrated.]

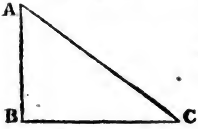
1. In every triangle, the greatest side is opposite to the greatest angle; and the greatest angle opposite to the greatest side.

2. In every triangle equal sides subtend equal angles. *(Art. 39, Geom.)*

3. The three angles of any plane triangle are equal to 180°. *(Art. 35, Geom.)*

4. If one angle of a triangle be obtuse, the rest are acute; and if one angle be right, the other two together make a right angle, or 90°; therefore, if one of the acute angles of a right-angled triangle be known, the other is found by subtracting the known angle from 90°. If one angle of any triangle be known, the sum of the other two is found by subtracting the given angle from 180°; and if two of the angles be known, the third is found by subtracting their sum from 180°.

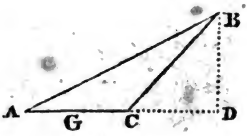
5. The complement of an angle is what it wants of 90°, and the supplement of an angle is what it wants of 180°.

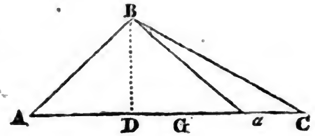


In the two following tables we have collected all the rules necessary for solving the various cases of Right-Angled and Oblique-Angled Trigonometry.

RIGHT-ANGLED TRIGONOMETRY.

Case.	Given.	Sought.	Solutions.
1	Hyp. AC. Angles.	Leg BC. Leg AB.	Rad. : hyp. AC. : : sine A. : leg BC. Rad. : hyp. AC. : : sine C. : leg AB.
2 & 3	Leg BC. Angles.	Leg AB. Hyp. AC.	Rad. : leg BC. : : tang. C. : leg AB. { Rad. : leg BC. : : sec. C. : hyp. AC. { Or Sine A : leg BC. : : rad. : hyp. AC.
4 & 5	Hyp. AC. Leg AB.	Angles. Leg BC.	Hyp. AC. : rad. : : leg AB. : sine C. whose comp. is A. Rad : hyp. AC. : : sine A. : leg. BC.
6	Both legs. AB & BC.	Angles. Hyp. AC.	Leg BC. : rad. : : leg AB. : tang. C. whose comp. is A. { Sine C. : leg AB. : : rad. : hyp. AC. { Or rad. : leg BC. : : sec. C. : hyp. AC.





Case	Given.	Sought.	Solutions.
1	The angles and side A B.	Side BC. Side AC.	Sine C : side AB : : sine A : side BC. Sine C : side AB : : sine B : side AC.
2 & 3	Two sides A B, BC, and angle C opposite to one of them.	Angle A. Angle B. Side AC.	Side AB : sine C : : side BC : sine A, which added to C, and the sum subtracted from 180° gives B. Sine C : side AB : : sine B : side AC.
4 & 5	Two sides A C, A B and the included angle A	Angles C and B. Side BC.	Subtract half the given angle A from 90°, the remainder is half the sum of the other angles. Then say, as the sum of the sides AC, AB is to their difference, so is the tangent of the half sum of the other angles to the tangent of half their difference; which added to and subtracted from the half sum, will give the two angles B and C the greatest angle being opposite to the greatest side. Sine B : side AC : : sine A : side BC.
6	All three sides.	All the angles.	Let fall a perpendicular BD opposite to the required angle; then as AC : sum of AB, BC : : their difference : twice DG, the distance of the perpendicular from the middle of the base; hence, AD, CD are known, and the triangle ABC is divided into two right-angled triangles BCD, BAD, then by cases 4 and 5 of right-angled trigonometry, we may find the angle A or C.
		Either angle, as A.	Either of the angles, as A, may also be found by the following rule. From half the sum of the three sides subtract the side BC opposite to the sought angle; take the logarithms of the half sum and remainder, to which add the arithmetical complements of the logarithms of the sides AB, AC (including the sought angle;) half the sum of these four logarithms will be the logarithmic co-sine of half the sought angle.

In working by logarithms with any of the preceding rules, you must remember, that *the logarithm of the first term of the analogy is to be subtracted from the sum of the logarithms of the second and third terms, the remainder will be the logarithm of the sought fourth term.*

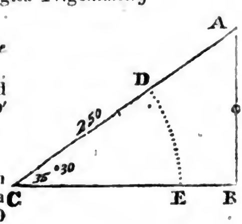
When the first term is radius (whose logarithm is 10,00000) you need only reject an unit in the second left hand figure of the index of the sum of the second and third terms. But when the radius occurs in the second or third term, you must suppose an unit to be added to the second left hand figure of the index of the other term, and subtract therefrom the logarithm of the first term.

RIGHT-ANGLED TRIGONOMETRY.

Solution of the six cases in right-angled Trigonometry.

CASE I.

The angles and hypotenuse given, to find the legs.



Given the hypotenuse AC 250 leagues, and the angle C opposite to the side AB=35° 30′ to find the base CB and perpendicular AB.

BY PROJECTION.

Draw the base CB of any length; with an extent equal to the chord of 60° and on C as a centre, describe the arch DE; from E to D lay off 35° 30′ taken from the line of chords,* through C and D draw the line AC, which make equal to 250; from A let fall the perpendicular AB, to cut CB in B, and it is done; for CB will be 203.5, and AB=145.2.

* In all projections of this kind the angles are measured from the line of chords, the radius used for describing arches by which the angles are to be measured, being equal to the chord of 60°, the sides of the triangles are measured by scales of equal parts as was before observed.

BY LOGARITHMS.

By making the hypotenuse CA radius, it will be,

To find the base BC.		To find the perpendicular AB.	
As radius	10.00000	As radius	10.00000
Is to the hypot. AC 250	2.39794	Is to the hypot. AC 250	2.39794
So is the sine ang. A 54° 30′	9.91069	So is sine ang. C 35° 30′	9.76395
To the base BC 203,5	2.30863	To the per. AB 145.2	2.16189

BY GUNTER'S SCALE.

In all proportions wrought by Gunter's Scale, when the first and second terms are of the same kind, the extent from the first term to the second, will reach from the third to the fourth.

Or when the first and third terms are of the same kind.

The extent from the first term to the third will reach from the second to the fourth; that is, set one point of the compasses on the division expressing the first term, and extend the other point to the division expressing the third term; then, without altering the opening of the compasses, set one point on the division representing the second term, and the other point will fall on the division showing the fourth term or answer.

In the present example the work will be as follows:

Extend from radius or 90°, to 54° 30′ on the line of sines; that extent will reach from 250, the hypotenuse, to 203.5, the base on the line of numbers; and the extent from radius, or 90°, to 35° 30′ on the line of sines, will reach from 250 to 145.2 on the line of numbers.

Observe the like in all that follows, except in those proportions where the word secant is mentioned, which cases must be wrought by considering the hypotenuse radius,* there being no line of secants on the common Gunter's Scale, although it might easily be marked on the line of sines.

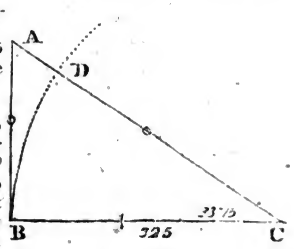
Note. The radius, according to the nature of the proportion, may be either of the following quantities.

8 points on the line of rhumbs.	90° on the line of sines.
4 points on the line of tan-rhumbs.	45° on the line of tangents.

CASES II. AND III.

The angles and one leg given, to find the hypotenuse and other leg.

The angle ACB 33° 15′, the leg BC 325 miles, given, to find the hypotenuse and the other leg.



BY PROJECTION.

Draw the line BC, which make equal to 325 miles; on B erect the perpendicular BA; on C, as a centre, with the chord of 60° sweep the arch BD, which make equal to 33° 15′; draw CD, and continue it to cut AB in A, and it is done; for AB being measured on the same scale that BC was, will be 213.1, and AC 388.6 miles.

BY LOGARITHMS.

By making the base BC radius, it will be,

To find the perpendicular AB.		To find the hypotenuse AC.	
As radius 45°	10.00000	As radius 90°	10.00000
Is to the base BC 325	2.51188	Is to the base BC 325	2.51188
So is tang. ang. C 33° 15′	9.81666	So is sec. ang. C 33° 15′	10.07765
To the perpen. AB 213.1	2.32854	To the hypot. AC 388.6	2.58953

BY GUNTER.

Extend from 45° to 33° 15′ on the line of tangents; that extent will reach from the base 325 to the perpendicular 213,1 on the line of numbers.

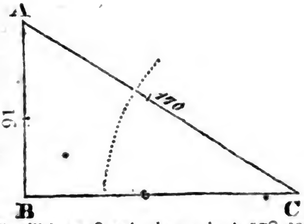
2dly. Extend from 56° 45′ to radius on the line of sines; that extent will reach from the base 325 to the hypotenuse 388,6 on the line of numbers.

* Or by using in the analogy radius : cos. angle instead of secant angle : Radius and radius : sine angle instead of co-secant angle : Radius.

CASES IV. AND V.

The hypotenuse and one leg given, to find the angles and other leg.

The leg AB 91, the hypotenuse AC 170, given, to find the angle ACB, or BAC, and the leg BC.



BY PROJECTION.

Draw BC at pleasure; on B erect the perpendicular BA, which make equal to 91; take 170 in your compasses, and with one foot on A, describe an arch to cut BC in C; join A and C, and it is done; for the angle C will be 32° 22′, the angle A 57° 38′, and BC 143,6.

BY LOGARITHMS.

By making the hypotenuse radius it will be,

To find the angle C.		To find the base BC.*	
As the hypotenuse 170	2.23045	As radius	10.00000
Is to radius	10.00000	Is to the hypotenuse 170	2.23045
So is the perpendicular 91	1.95904	So is sine ang. A 57° 38′	9.92667
To sine angle C 32° 22′	9.72859	To the base BC 143,6	2.15712

BY GUNTER.

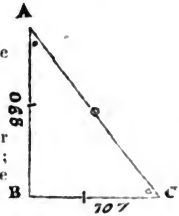
Extend from the hypotenuse 170 to the perpendicular 91 on the line of numbers; that extent will reach from radius to the angle C, or the complement of angle A=32° 22′ on the line of sines.

2dly. Extend from radius to the angle A 57° 38′ on the line of sines; that extent will reach from the hypotenuse 170 to the base 143.6, on the line of numbers.

CASE VI.

The legs given, to find the angles and hypotenuse.

The legs AB 890, BC 707, given, to find the angle BAC or ACB, and the hypotenuse AC.



BY PROJECTION.

Make BC=707, and on B erect the perpendicular BA, which make equal to 890; join AC, and it is done; for the angle C will be 51° 32′; consequently the angle A 38° 28′, and the hypotenuse 1137.

BY LOGARITHMS.

By making the base radius, it will be,

To find the angle C.		To find the hypotenuse AC.†	
As the base 707	2.84942	As radius	10.00000
Is to radius	10.00000	Is to the base 707	2.84942
So is the perpendicular 890	2.94939	So is the sec. ang. C 51° 32	10.20617
To tan. ang. C=51° 32′	10.09997	To the hyp. AC=1137	3.05559

BY GUNTER.

The extent from 707 to 890 on the line of numbers will reach from radius, or 45 degrees, to the angle C 51° 32′ on the line of tangents.

2dly. The extent from the angle C 51° 32′ to radius, or 90°, on the line of sines, will reach from the base 890 to the hypotenuse 1137, on the line of numbers.

* When you take the log. sines, or tangents to the nearest minute only, it is best to use this canon for finding BC, which is more correct than the one found by making the perpendicular radius; because the variation of the log. sine of an arch is less than the corresponding variation of the log. tangent.

† When you are finding AC it is best to make the greatest side radius, for the reason mentioned in the last note.

QUESTIONS

To exercise the learner in Right-Angled Plane Trigonometry.

Quest. 1. The hypotenuse 496 miles, and the angle opposite to the base 56° 15′, given, to find the base and perpendicular.

Ans. Base 412.4, and the perpendicular 275.6 miles.

Quest. 2. The perpendicular 275 leagues, and the angle opposite to the base 56° 15′, given, to find the hypotenuse and base.

Ans. The hypotenuse 495, and base 411.6 leagues.

Quest. 3. The base 33 yards, and the angle opposite to the perpendicular 53° 26′, given, to find the hypotenuse and perpendicular.

Ans. Hypotenuse 55.39, and the perpendicular 44.49 yards.

Quest. 4. The hypotenuse 575, and perpendicular 50 miles, given, to find the base.

Ans. Base 572.8 miles.

Quest. 5. The hypotenuse 59, and the base 33 miles, given, to find the perpendicular.

Ans. Perpendicular 48.9 miles.

Quest. 6. The base 33, and perpendicular 52 leagues given, to find the hypotenuse.

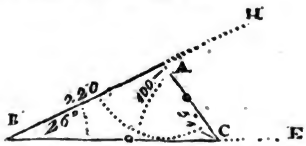
Ans. Hypotenuse 61.59 leagues.

OBLIQUE TRIGONOMETRY.

CASE I.

Two angles and one side given, to find either of the legs.

Given the angle BAC=100° the angle ACB=54° and the leg AB=220 to find the sides.



BY PROJECTION.

Subtract the sum of the angles A and C from 180°, the remainder will be the angle B=26°. Draw the indefinite line BE, also the line BH, making the angle EBH=26°, on BH set off BA 220. On A make the angle BAC 100°; then AC will intersect the line BE in the point C, which completes the triangle, and BC will measure (on the same scale from which BA was laid down) 268 nearly, and AC 119.

BY LOGARITHMS by Theorem II.

To find BC.		To find DC.	
As the sine of the angle C 54°	9.90796	As sine ang. C 54°	9.90796
Is to the side AB 220	2.34242	Is to the side AB 220	2.34242
So is the sine of the ang. A 100°	9.99335	So is the sine ang. B 26°	9.64184
	12.33577		11.98426
	9.90796		9.90796
To the side BC 267.8	2.42781	To side AC 119.2	2.07630

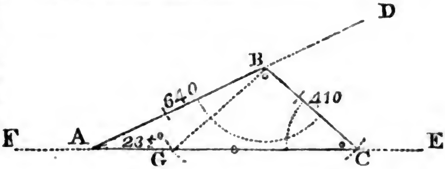
BY GUNTER.

The extent from the angle C=54° to the angle A or its supplement 80° on the sines, will reach from AB=220 to BC=268 on the line of numbers.

2dly. The extent from the angle C=54° to the angle B=26°, on the sines, will reach from AB=220 to AC=119 on the line of numbers.

CASES II. AND III.

Two sides and an angle opposite to one of them being given, to find the other angles and the third side.



Note. It may be proper to observe, that if the given angle be obtuse, the angle sought will be acute: but when the given angle is acute and opposite to a lesser given side, then it is doubtful whether the required angle is acute or obtuse; it ought therefore to be given by the conditions of the problem.

Example. Let there be given the side BC 410, the side AB 640, and the angle A 23½°, to find the other side AC, and the angles ABC, BCA.

BY PROJECTION.

Draw the indefinite line FE, make the angle DAE=23½°, on AD set off AB=640, then on B, with 410 in your compasses taken from the same scale, describe an arch cutting FE in the points C and G, join BC, BG, and it is done; for the triangle may be either ACB, or AGB, according as the angle C, or G, is acute or obtuse; if that angle be acute, the triangle will be ABC; the side AC will measure 908, the angle ACB will measure 38½°, and the angle ABC will measure 118° nearly; but if the angle at the base be obtuse, the triangle will be AGB; the side AG will measure 266, the angle AGB will measure 141½° and the angle ABG 15°.

If the side BC had been given greater than AB, there could have been only one answer to this problem; for in that case, the point G would have fallen on the continuation of the line CA towards F, in which case the angle A of the triangle would become equal to FAB, instead of being equal to its supplement, as is required by the conditions of the problem.

BY LOGARITHMS, by Theorem II.

To find the angle C or G.	
As the side BC 410	2.61278
Is to the sine of angle A 23½°	9.60070
So is the side AB 640	2.80618
	12.40688
	2.61278
To sine ang. C 38 30 or G 141 30	9.79410
Angle A add 23 30 — 23 30	
Subtract 62 0 or 165 0	
From 180 0 — 180 0	
Ang. ABC 118 0 ABG 15 0	

To find AC.	
As sine angle C 38° 30′	9.79410
Is to AB 640	2.80618
So is sine angle ABC 118°	9.94593
	12.75211
	9.79410
To the side AC 907,8	2.95801
To find AG.	
As sine angle G 141° 30′	9.79410
Is to AB 640	2.80618
So is sine angle ABG 15°	9.41300
	12.21918
	9.79410
To the side AG 266,1	2.42508

BY GUNTER.

1st. The extent from BC=410 to AB=640, on the line of numbers, will reach from A=23½°, to 38½°, on the line of sines, which is equal to the angle C; its supplement 141° 30′ being equal to the angle G.

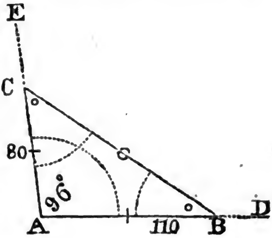
2dly. The extent from the angle C=38° 30′ to 62° 0′ (the supplement of the angle ABC, 118° 0′) on the sines, will reach from AB=640 to 908, on the line of numbers; therefore the side AC=908.

Or, the extent from 38° 30′ (the supplement of the angle G) to the angle ABG=15° 0′ on the sines, will reach from AB=640 to 266, on the line of numbers: hence AG=266.

CASES IV. AND V.

Two sides and their contained angle being given, to find either of the other angles and the third side.

Given the side AB 110 m. AC 80 m. and angle BAC 96° 0′ to find the angles BCA and CBA.



BY PROJECTION.

Draw the indefinite right line AD, on which set off AB=110; make the angle EAB=96°; and on AE set off AC=80; join BC, and it is done; for BC will measure on the former scale 143, and the angles B and C will measure 33° 55′ and 50° 5′ respectively on the line of chords.

BY LOGARITHMS.

To find the angles B and C by Th. III.		To find the side BC by Theorem II.	
As sum of sides AC and AB 190	2.27875	As sine ang. B 33° 55′	9.74662
Is to their difference 30	1.47712	Is to AC 80	1.90309
So is tang. ½ sum op. <'s or comp. ½ ang. A. } 42°	9.95444	So is sine ang. A 96° 0′ or its sup. 84 0	9.99761
	11.43156		11.90070
	2.27875		9.74662
To tang. half diff.	8° 5′=9.15281	To side BC 142.6	2.15408
Sum is angle C	50 5		
Diff. is angle B	33 55		

BY GUNTER.

1st. The extent from the sum of the sides 190 to their difference 30 on the line of numbers, will reach from the half sum of the angles B and C 42° to their half difference 8° 5′ on the line of tangents. The sum of which half sum and half difference gives the angle C 50° 5′ and their difference the angle B 33° 55′; the greatest angle being opposite to the greatest side.

2dly. The extent from the angle B 33° 55′, to the angle A 96° (or its supplement 84°) on the line of sines, will reach from the side AC 80 to the side BC 142,6 on the line of numbers.

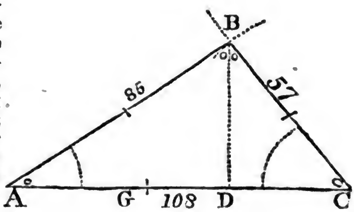
CASE VI.

The three sides of a plane triangle given, to find the angles.

The sides AB 85, BC 57, AC 108 given, to find the angles ABC, BAC, BCA.

BY PROJECTION.

Draw the line AC, and make it equal to 108; take 85 in your compasses, and with one foot on the point A, describe an arch; then take the distance 57 in your compasses, and with one foot on C, describe another arch intersecting the former arch in the point B; join AB, CB, and it is done. For the angle A being measured will be found=31½°, B=97°, and the angle C=51½° nearly.



BY LOGARITHMS, by Theorem IV.

Suppose BD to be drawn perpendicular to AC, and that AG=GC.

Side AB=85		As the base AC 108		2.03342
Side BC=57		Is to the sum of the sides AB and BG 142		2.15229
		So is diff. of the sides AB and BC 28		1.44716
Sum of the sides	142			
Diff. of the sides	28			3.59945
				2.03342
Half base AC	54			
DG	18.4	To twice DG	36,8	1.56603
		Its half=DG	18,4	
Sum is greater seg. AD	72.4			
Diff. is least seg. DC	35.6			

Having divided the triangle into two right-angled triangles, the hypotenuses and bases of which are given, we may find the angles by Theorem 1.

To find the angle BAD.	
As the hypotenuse AB 85	1.92942
Is to radius 90°	10.00000
So is the greater seg. AD 72,4	1.85974
To co-sine BAD=31° 36′	9.93032

To find the angle BCD.			
As the hypotenuse BC 57			1.75587
Is to radius 90°			10.00000
So is the lesser seg. DC 35,6			1.55145
To co-sine of BCD=51° 21′			9.79558
BAD=31	36		
Sum	82	57	
Subtract from	180		
Remains angle ABC	97	3	

BY GUNTER.

1st. The extent from the base AC=108, to the sum of the sides 142, on the line of numbers, will reach from the difference of the sides 28, to twice DG 36.8 on the same line of numbers.

2dly. The extent from the hypotenuse AB=85, to the greater segment AD 72.4, on the line of numbers, will reach on the sines from the radius 90° to 58° 24′ which is the complement of the angle BAD.

3dly. The extent from the hypotenuse CB 57, to the lesser segment DC 35.6 on the line of numbers, will reach on the sines from the radius 90° to 38° 39′, which is the complement of the angle BCA.

This case may be solved without dividing the triangle into two right-angled triangles by Theorem V.

To find the angle A.		
BC= 57		
AB= 85	log. co. ar.	8.07058
AC=108	log. co. ar.	7.96658
Sum 250		
Half sum 125	log.	2.09691
Half sum less BC 68	log.	1.83251
	Sum)	19.96658
Half sum 15° 48′	Co-sine	9.98329
2		
Doubled is 31 36=angle A.		

Having the angle A, we may find the angle C by Theorem II.	
As BC 57	1.75587
Is to sine angle A 31° 36′	9.71932
So is AB 85	1.92942
	11.64874
	1.75587
To the sine of angle C 51° 23′	9.89287

ASTRONOMY AND GEOGRAPHY.

ASTRONOMY is the science which treats of the motions and distances of the heavenly bodies, and of the appearances thence arising.

Geography is the science which treats of the situations and distances of the various parts of the surface of the earth.

The common opinion of astronomers of the present day is, that the universe is composed of an infinite number of systems or worlds; that in every system there are certain bodies moving in free space, and revolving at different distances round a sun, placed in or near the centre of the system; and that these suns and other bodies are the stars which are seen in the heavens.

The Solar System, so called, is that in which our earth is placed, and in which the sun is supposed to be fixed near the centre, with several bodies, similar to our earth, revolving round at different distances. This hypothesis, which is fully confirmed by observation, is called the Copernican System, from Nicholas Copernicus, a Polish Philosopher, who revived it about the year 1500, after it had been buried in oblivion many ages.

Stars are distinguished into two kinds, *fixed* and *wandering*. The former are supposed to be suns in the centres of their systems, shining with their own light, and preserving nearly the same situation with respect to each other. They are usually distinguished by their brightness, the largest being called of the first magnitude, and the smallest visible to the naked eye being of the sixth or seventh magnitude. A *Constellation* is a number of stars lying in the neighbourhood of one another on the surface of a celestial sphere, which astronomers, for the sake of remembering with greater ease, suppose to be circumscribed by the outlines of some animal or other figure. The wandering stars are those bodies within our system, or celestial sphere, which revolve round the sun; they appear luminous by reflecting the light of the sun, and are of three kinds, namely *primary planets*, *secondary planets*, and *comets*.

The *Primary Planets* are bodies which revolve round the sun, as the centre of their courses, the motions being regularly performed in tracks or paths (called *orbits*) that are nearly circular and concentric with each other. A *Secondary Planet*, *Satellite*, or *Moon*, is a body which, while it is carried round the sun, revolves also round a primary planet. *Comets* are a sort of planets moving round the sun in very eccentric orbits, with vast atmospheres about them, and tails derived from the same.

There are eleven primary planets, which, reckoned in order from the sun, are as follows: Mercury, Venus, the Earth, Mars, Vesta, Juno, Pallas, Ceres, Jupiter, Saturn, and Uranus.

Mercury and Venus are called *inferior planets*, because their orbits are within the earth's; the others are called *superior planets*, as their orbits include that of the earth.

The Sun, the first and greatest object of astronomical knowledge, is placed near the centre of the orbits of all the planets, and turns round its axis in 25½ days; its diameter is 883,000 English miles, and its mean distance from the earth 95 millions of miles.

Mercury is the least of all the planets, known before the discovery of Vesta, Juno, Pallas, and Ceres, and is the nearest to the sun, his mean distance from that luminary being 37 millions of miles. His periodic revolution in his orbit round the sun is performed in 87 days 23 hours, and his diameter is about 3200 miles.

Venus is the brightest of all the planets. Her diameter is 7687 miles; her mean distance from the sun 68 millions of miles; and her periodic revolution is performed in 224 days 17 hours. When this planet is in that part of her orbit which is west of the sun, she rises before him in the morning, and is called the *morning star;* when she is in the eastern part of her orbit, she shines in the evening, after he sets, and is called the *evening star*.

The next planet is the EARTH, the diameter of which is 7964 miles, the distance from the sun 95 millions of miles, and the time of revolution round

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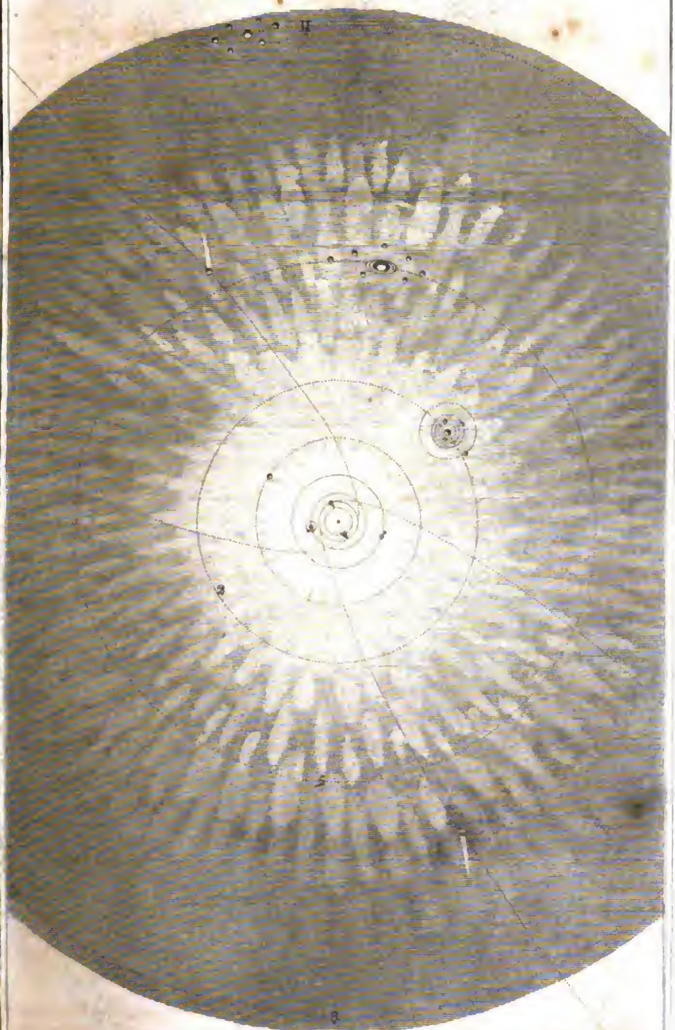
Plate III.

THE SOLAR SYSTEM.



1 ☿ Mercury
2 ♀ Venus
3 ⊕ Earth & Moon
4 ♂ Mars
5 Juno Pallas Ceres & Vesta
6 ♃ Jupiter & his 4 Moons
7 ♄ Saturn & her 7 Moons
8 ♅ Uranus & his 6 Moons

Each of the two elliptical curves represents the orbit of a Comet

Hooker Engd.

the sun one year. The earth turns round its axis from west to east in 23h. 56m. which occasions the apparent diurnal motion of the sun and all the heavenly bodies round it from east to west in the same time, and is, of course, the cause of their rising and setting, of day and night. The axis of the earth is inclined about 23° 28′ to the plane of its orbit,* and keeps nearly in a direction parallel to itself, throughout its annual course, which causes the return of spring and summer, autumn and winter. Thus the diurnal motion gives us the grateful vicissitude of night and day, and the annual motion the regular succession of the seasons. The earth is attended by a satellite called the MOON, whose diameter is 2161 miles; her distance from the centre of the earth is 240,000 miles: she goes round her orbit in 27 days 8 hours; but, reckoning from change to change, in 29½ days. Her orbit is inclined to the ecliptic in an angle of 5° 9′, cutting it in two points diametrically opposite to each other, called her *nodes*. As the moon shines only by the reflected light of the sun, she must appear different when in different situations with respect to that luminary. When she is in conjunction with the sun, her dark side is turned towards the earth, which renders her invisible; this is called *new moon:* when she is in opposition, her light side is wholly visible from the earth; this is called *full moon*.

If at the time of new moon she is near to either of her nodes, she may intercept a part of the sun's light, and thus cause an *eclipse of the sun;* and if she is near either of her nodes at the time of full moon, she may pass into the shadow of the earth, and cause an *eclipse of the moon*. In a similar manner, when the moon passes between an observer on the earth and a star, it is called an *Occultation* of the star. The instant when the moon's limb first covers the star is called the *Immersion*, and the moment of its re-appearance is called the *Emersion*. When Mercury or Venus passes between the sun and an observer, and appears to pass over the sun's disk, it is called a *Transit* of Mercury or Venus. Eclipses, Occultations and Transits, are of great importance in ascertaining the longitudes of places on the earth. Eclipses of the moon furnish a convincing proof of the rotundity of the earth, since the shadow of the earth, seen upon the moon when eclipsed, is always circular. This is farther confirmed by the appearance of objects at sea; for when a ship is making towards the land, the mariners first descry the tops of steeples, trees, &c. pointing above the water; the lower parts being hid, by reason of the curvature of the earth.

The earth is not a perfect globe or sphere, but is a little flatted at the poles, being nearly of the figure of an oblate spheriod, the equatorial diameter being about 26 miles longer than the polar: but since this difference bears but a small comparison to the whole diameter, we may, for all the practical purposes of navigation, consider the earth as a perfect sphere, as will be done in the rest of this work. The natural divisions of the earth will be given hereafter.

MARS is the next planet to the earth; his diameter is 4189 miles, his distance from the sun 144 millions of miles, and his periodic revolution is performed in about 687 days. He revolves round his axis in 24 hours 40 minutes, appearing of a dusky reddish hue, and is supposed to be encompassed with a very great atmosphere.

Between Mars and Jupiter are situated the four lately discovered planets, Vesta, Juno, Pallas, and Ceres, named Asteroids by Doctor Herschel. The elements of their orbits have not been accurately ascertained, but are nearly as in the following description.

VESTA, was discovered by Doctor Olbers of Bremen, on the 29th of March, 1807. Its mean distance from the sun is about 205 millions of miles; its periodic revolution is performed in about 3 1-6 years.

JUNO, was discovered by Mr. Harding, of Lilienthal (near Bremen) on the first of September, 1804. It appears like a star of the eighth magnitude. Its distance from the sun is about 255 millions of miles; its periodic revolution is performed in 1582 days. The inclination of its orbit to the ecliptic is 13° 50′ and the eccentricity of the orbit† 0.25.

* The Inclination decreases at present about 50″ in 100 years, by reason of the attraction of the planets on the earth. It is also affected by the Nutation given in Table XLIII. which sometimes amounts to 9″.

† In estimating the eccentricities of the planets, their mean distance from the sun is put equal to unity.

PALLAS, was also discovered by Dr. Olbers, March 28, 1802. Its diameter, according to Doctor Herschel, is only 110 miles; it appears like a star of the eighth magnitude. Its mean distance from the sun is about 266 millions of miles. Its periodic revolution is performed in 1683 days. The inclination of its orbit to the ecliptic is 34° 39′ and the eccentricity of the orbit 0.2463.

CERES, was discovered by Mr. Piazzi of Palermo on the first of January, 1801. Its diameter, according to Dr. Herschel, is only 160 miles. It appears like a star of the seventh or eighth magnitude. Its distance from the sun is about 266 millions of miles, and its periodic revolution is performed in 1683 days, being at nearly the same distance from the sun as Pallas. The inclination of the orbit of Ceres to the ecliptic is 10° 37′ and the eccentricity 0,097. The situations of the nodes of the two planets Ceres and Pallas, and the inclinations of their orbits, are very different from each other, so that when those planets are in the same plane, they are at a great distance from each other, notwithstanding their mean distances from the sun are nearly equal. It has been supposed by some, that these small bodies are fragments of a former planet.

JUPITER is situated still higher in the system, and is the largest of all the planets, being easily distinguished from them by his peculiar magnitude and light. His diameter is 89,170 miles, his distance from the sun 490 millions of miles, and the time of his periodic revolution is 4332½ days. Though Jupiter is the largest of all the planets, yet his diurnal revolution is the swiftest, being only 9 hours and 56 minutes.

Jupiter is attended by four satellites, invisible to the naked eye, but through a telescope they make a beautiful appearance. In speaking of them, we distinguish them according to their places, into the first, second, and so on; by the first we mean that which is nearest to the planet. The appearance of these satellites is marked in the XIIth. page of the Nautical Almanac, for some particular hour of the night; the times when they are eclipsed, by passing into the shadow of Jupiter, are also given in the Nautical Almanac; these eclipses are of considerable use in determining the longitudes of places on the earth.

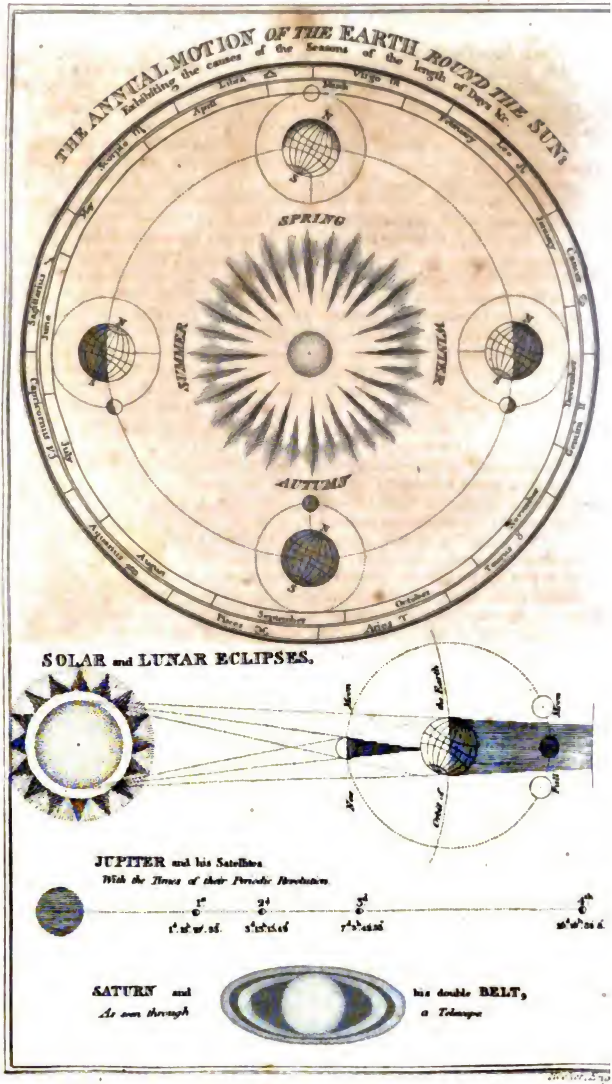
Before the discovery of the planet Uranus, SATURN was reckoned the most remote planet of our system. He shines with but a pale and feeble light. His diameter is 79,042 miles, his distance from the sun 900 millions of miles, and his periodic revolution in his orbit is performed in about 29 years 167 days. This planet is surrounded with a broad flat ring, has a diurnal revolution round its axis, and is attended by seven satellites.

By some observations made by Dr. Herschel, it appeared that the largest diameter of Saturn corresponds to the latitude of 45°, but from later observations he has been induced to believe, that this irregularity is owing to an optical deception, arising from the refraction of the light in passing through the atmosphere of the ring.

URANUS, Herschel, or Georgium Sidus, is the most remote planet of our system. It was discovered in the year 1781, by Dr. Herschel, though it had been seen several times, but had been considered as a fixed star. Its diameter is 35,109 miles, its distance from the sun 1800 millions of miles, and its periodic revolution in its orbit is performed in 83½ years. Dr. Herschel has also discovered six satellites attending this planet.

The astronomy of comets is yet in its infancy. The return of one of them in the year 1758 was foretold by Dr. Halley, and it happened nearly as he predicted. He also foretold the return of another in the year 1790, but it never appeared. This was owing to the inaccuracy of the observations of the comet at its former appearance; for Mr. Mechain, having collected all the observations, and calculated the orbit again, found it to differ essentially from that determined by Dr. Halley. Olber's comet, which appeared in 1815, has a revolution of 72 years; and Encke's comet, which has been observed in several successive approaches to the perihelion, completes its revolution in the short period of 1204 days.

Comets move round the sun in all directions, but the planets and satellites, except one of the satellites of Uranus, move from west to east when seen from the sun; but if viewed from any other of the planets, as the earth, they would appear to revolve round it as a centre; but the sun would be the only one that moved uniformly the same way, for the other planets would some-



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times appear to move from west to east, and then to stand still; then they would seem to move from east to west; and after standing some time, they would again move from west to east; and so on continually. The motion of a planet from west to east is called the *direct* motion, or *according to the order of the signs*. The contrary motion from east to west, is called *retrograde*. When the planet appears to stand still, it is said to be *stationary*.

To illustrate what has already been said relative to the motions and distances of the planets and satellites, we have given the adjoining Plates III. and IV. which require no explanation.

In noting the situations of the stars and planets, astronomers have been under the necessity of imagining various lines and circles on the sphere; and geographers have done the same for fixing the situation of places on the earth. The most remarkable of these are the following.

A *great circle* is that whose plane passes through the centre of the sphere; and a *small circle* is that whose plane does not pass through that centre.

A diameter of a sphere, perpendicular to any great circle, is called the *axis* of that circle; and the extremities of a diameter are called its *poles*. Hence the pole of a great circle is 90° from every point of it upon the surface of the sphere; but as the axis is perpendicular to the circle when it is perpendicular to any two radii, a point on the surface of a sphere 90° distant from any two points of a great circle will be the pole.

All angular distances on the surface of a sphere, to an eye at the centre, are measured by arcs of *great* circles. Hence all triangles formed upon the surface of a sphere, for the solution of spherical problems, must be formed by the arcs of great circles.

Secondaries to a great circle are great circles which pass through its poles, and consequently must be perpendicular to their great circles.

The *axis* of the earth is that diameter about which it performs its diurnal motion; and the extremities of this diameter are called the poles.

The *terrestrial equator* is a great circle of the earth perpendicular to its axis. Hence the axis and poles of the earth are the axis and poles of its equator. That half of the earth which lies on the side of the equator, in which Europe and the United States of America are situated, is called the *northern hemisphere*, and the other the *southern*; and the poles are respectively called the *north* and *south* poles.

The *latitude* of a place upon the earth's surface is its angular distance from the equator, measured upon a secondary to it. These secondaries to the equator are called *meridians*.

The *longitude* of a place on the earth's surface is an arc of the equator intercepted between the meridian passing through the place, and another, called the *first meridian*, passing through that place from which you begin to measure, or it is the angle formed at the pole by these two meridians. The Americans and English generally place the first meridian at London or Greenwich, the French place it at Paris, the Spaniards at Cadiz; some Geographers place it at Teneriffe, and others at other places. Throughout this work Greenwich will be reckoned as the first meridian. The longitude is counted from the first meridian, both eastward and westward, till it meets at the same meridian on the opposite point; therefore the longitude (and also the difference of longitude between any two places) can never exceed 180°.

If the plane of the *terrestrial* equator be produced to the sphere of the fixed stars, it marks out a circle called the *celestial equator*; and if the axis of the earth be produced in like manner, the points of the heavens, to which it is produced, are called poles, being the *poles* of the celestial equator. The star nearest to each pole is called the *pole* star.

Secondaries to the celestial equator are called *circles of declination*; of these 24, which divide the equator into equal parts, each containing 15°, are called *hour* circles.

Small circles parallel to the celestial equator are called *parallels* of declination.

The *sensible* horizon is that circle in the heavens whose plane touches the earth at the spectator. The *rational* horizon is a great circle in the heavens, passing through the earth's centre, parallel to the sensible horizon.

If the radius drawn from the centre of the earth to the place where the spectator stands be produced both ways to the heavens, the point vertical to him is called the *zenith*, and the point opposite, the *nadir*. Hence the *zenith* and *nadir* are the poles of the rational horizon.

Secondaries to the horizon are called *vertical* circles, because they are perpendicular to the horizon. On these circles, therefore, the altitude of a heavenly body is measured.

The secondary common to the celestial equator, and the horizon of any place, is the *celestial meridian* of that place. This meridian corresponds with the *terrestrial meridian* of the same place, which passes through the poles of the earth, the zenith and nadir crossing the equator at right angles, and cutting the horizon in the north and south points; that point being called *north* which passes through the north pole, and the opposite direction is called *south*. The vertical circle which cuts the meridian of any place at right angles is called the *prime* vertical; the points where it cuts the horizon are called the east and west points, and to an observer, with his face directed towards the south, the *east* point will be to his left hand, and the *west* to his right hand. Hence the east and west points are 90° distant from the north and south. These four are called the *cardinal* points. The meridian of any place divides the heavens into two hemispheres lying to the east and west; that lying to the east is called the *eastern* hemisphere, and the other the *western* hemisphere. When the sun is at its greatest altitude on the meridian of any place, it is noon or mid-day.

The *azimuth* of an heavenly body is its distance on the horizon, when referred to it by a secondary, from the north or south points. The *amplitude* is its distance from the east or west points, at the time of rising or setting.

The *ecliptic* is that great circle in the heavens which the sun appears to describe in the course of a year. The ecliptic and equator, being great circles, must bisect each other, and their angle of inclination is called the *obliquity of the ecliptic;* and the points where they intersect are called the *equinoctial points*. The times when the sun comes to these points are called the *equinoxes*. The ecliptic is divided into 12 equal parts, called *signs*;—viz. Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏, Sagittarius ♐, Capricornus ♑, Aquarius ♒, Pisces ♓. The order of these is according to the apparent motion of the sun. The first point of Aries coincides with one of the equinoctial points, and the first point of Libra with the other. The first six signs are called *northern*, lying on the north side of the equator; and the last six are called *southern*, lying on the south side.

The *zodiac* is a space extending eight degrees on each side the ecliptic, within which the motion of all the planets is contained, except the newly discovered planets.

The *right ascension* of a body is an arc of the equator intercepted between the first point of Aries and a circle of declination passing through the body, measured according to the order of the signs.

Right ascension of the meridian or mid-heaven, is the distance of the meridian, from the first point of Aries, and is found by adding the apparent time past noon, to the sun's right ascension.

The *ascensional difference* of any object is the difference between the right ascension of the object and that point of the equator which rises or sets with it.

The *declination* of a star or any celestial object is its angular distance from the equator, measured upon a secondary to it passing through the object.

The *longitude* of a star or any celestial object is an arc of the ecliptic intercepted between the first point for Aries and a secondary to the ecliptic passing through the body, measured according to the order of the signs.—If the observer be on the earth, the longitude is called the *geocentric* longitude; but if seen from the sun it is called the *heliocentric* longitude; the body in each case being referred perpendicularly to the ecliptic in a plane passing through the eye.

Nonagesimal degree of the ecliptic is its highest point at any given time, and is 90° from the points where the ecliptic intersects the horizon.

The *latitude* of a star or any celestial object is its angular distance from the ecliptic, measured upon a secondary to it drawn through the body.—If the body be observed from the earth, its angular distance from the ecliptic is called the *geocentric* latitude; but if observed from the sun it is called the

heliocentric latitude. The secondary circle drawn perpendicular to the ecliptic is called a *circle of latitude*.

The *tropics* are two parallels of declination touching the ecliptic. One, touching it at the beginning of cancer, is called the *tropic of cancer;* and the other, touching it at the beginning of capricorn, is called the *tropic of capricorn*. The two points, where the tropics cut the ecliptic, are called the *solstitial* points.

Colures are two secondaries to the celestial equator, one passing through the equinoctial points, called the *equinoctial* colure; and the other passing through the solstitial points, are called the *solstitial* colure. The times when the sun comes to the solstitial points are called the *solstices*.

Aberration of a star or any heavenly body, is a small apparent motion, occasioned by the progressive velocity of light. This is calculated by means of Tables XXXIX. XLI. or XLII.

Nutation is a small apparent motion of the heavenly bodies, occasioned by a real motion of the earth's axis, arising from the attractions of the sun and moon on the spheroidal form of the earth. The effect of this on the right ascension and declination is given in Table XLIII. and on the longitude in Table XL. The correction in this last Table being generally called the equation of the equinoxes in longitude.

Precession of the equinoctial points is a small motion of about $50\frac{1}{4}''$ per year, occasioned by the same cause as the nutation. By this motion the equinoctial points are carried backward from east to west; consequently, the heavenly bodies appear to move forward the same quantity from west to east. The annual variations of the places of the stars from precession, and the secular equations arising from the change of the earth's orbit by the attraction of the planets, are given in Tables VIII. and XXXVII.

The *arctic* and *antarctic* circles are two parallels of declination, the former about the north, and the latter about the south pole, the distance of which from the two poles is equal to the distance of the tropics from the equator, which is about $23^\circ 28'$. These are also called polar circles. The two tropics and two polar circles, when referred to the earth, divide it into five parts, called *zones;* the two parts within the polar circles are called the *frigid* zones; the two parts between the polar circles and tropics are called the *temperate* zones; and the part between the tropics is called the *torrid* zone.

Besides the imaginary divisions of the earth, there are various natural divisions of its surface, formed by nature, such as continents, oceans, islands, seas, rivers, &c.

A *Continent* is a large tract of land, wherein are several empires, kingdoms, and countries conjoined—as Europe, Asia, Africa, and America.

An *Island* is a part of the earth that is environed or encompassed round by the sea, as Long Island, Block Island, &c.

A *Peninsula* is a portion of land almost surrounded with water, save one narrow neck which joins it to the continent, as the Morea.

An *Isthmus* is a narrow neck of land joining a peninsula to the adjacent land, by which the people may pass from one to the other, as the isthmus of Darien.

A *Promontory* is a high part of land stretching itself into the sea, the extremity of which is called a Cape or Headland.

A *Mountain* is a rising part of dry land, over-topping the adjacent country, and appearing first at a distance.

An *Ocean* is a vast collection of water, separating continents from one another, and washing their borders or shores, as the Atlantic and Pacific Oceans.

A *Sea* is part of the ocean, to which we must sail through some strait, as the Mediterranean and Baltic seas. This term is sometimes used for the whole body of salt water on the globe.

A *Strait* is a narrow part of the ocean lying between two shores, and opening a way into some sea, as the Straits of Gibraltar that lead into the Mediterranean Sea.

A *Creek* is a small narrow part of the sea or river, that goes up but a little way into the land.

A *Bay* is a great inlet of the land, as the Bay of Biscay, and the Bay of Mexico; otherwise a bay is a station or road for ships to anchor in.

A *River* is a considerable stream of water issuing out of one or various springs, and continually gliding along in one or more channels, till it discharges itself into the ocean: the lesser streams are called rivulets.

A *Lake* is a large collection of waters in an inland place, as the lakes Superior and Huron in America.

A *Gulf* is a part of the ocean or sea, nearly surrounded by the land, except where it communicates with the sea, as the Gulf of Venice.

Thus we have given the most useful definitions of Astronomy and Geography, and to assist the learner there is also given Plate V. in which those terms are explained at one view. We may farther observe, that as the latitude of any place upon the earth is counted from the equator upon an arch of the meridian, the difference of latitude between two places, both north, or both south, is found by *subtracting the less latitude from the greater; but if one latitude be north, and the other south, the difference is found by adding both latitudes together.*

1. Consequently, if a ship in north latitude sails northerly, or in south latitude southerly, she increases her latitude; but in north latitude sailing southerly, or in south latitude sailing northerly, she decreases her latitude, because she sails nearer to the equator, from whence the latitude is reckoned.

2. Wherefore, *in north latitude sailing northerly, or in south latitude sailing southerly, the difference of latitude, added to the latitude left, gives the latitude in.*

3. *In north latitude sailing southerly, or in south latitude sailing northerly, the difference of latitude, subtracted from the latitude left, gives the latitude in.*

4. *When the latitude decreases, and the difference of latitude is greater than the latitude sailed from, subtract the latitude left from the difference of latitude, and the remainder will be the latitude in, but of a different name, for it is evident in this case, that the ship has crossed the equator.*

5. The difference of longitude between two places, being both east or west, is found *by subtracting the less longitude from the greater; but if one be in east longitude and the other in west, their sum is the difference of longitude, when it does not exceed* 180°, *but if it exceeds* 180°, *that sum must be subtracted from* 360°, *and the remainder will be the difference of longitude.*

6. *Therefore in east longitude sailing easterly, or in west longitude sailing westerly, the difference of longitude added to the longitude left, gives the longitude in,* when that sum does not exceed 180°; but if it exceeds 180°, the sum, subtracted* from 360°, leaves the longitude in, but of a different name from that left.

7. *In east longitude sailing westerly, or in west longitude sailing easterly, the difference of longitude, subtracted from the longitude left, gives the longitude in; but when the difference of longitude is greatest, the longitude left must be subtracted from that difference, and the remainder will be the longitude in, but of a different name from the longitude left.*

What has been said will be rendered familiar to the learner by the following examples.

EXAM. I. What is the difference of latitude between Boston, in the latitude of 42° 23′ N. and Richmond (Virginia) in the lat. of 37° 30′ N.?

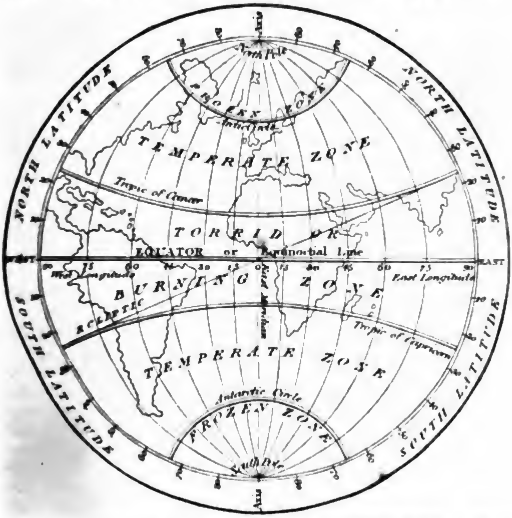
From Boston's lat.	42° 23′ N.
Subtract Richmond's lat.	37 30 N.
Remains the diff. of lat.	4 53
	60
In Miles	293

EXAM. II. A ship from latitude 59° 27′ S. sails southward until her difference of latitude is 374 miles; what latitude is she come to?

Latitude sailed from	59° 27′ S.
Diff. of lat. 374÷60=	6 14 S.
Lat. in	65 41 S.

* In this rule it is supposed, that the sum of the longitude left, and the difference of longitude, is less than 360°, which is always the case when the difference of longitude is less than 180°, which we have generally supposed to be the case in these rules.

THE CIRCLES, ZONES, &C: OF THE ARTIFICIAL GLOBE OR SPHERE



EXPLANATION OF GEOGRAPHICAL TERMS.

Published ... 1823

Ex. III. Required the difference of latitude between Georgetown and Cape Frio?

Georgetown's lat.	33° 25′	N.
Cape Frio's lat.	23 1	S.
Diff. of lat.	56 24	
	60	
In miles	3384	

Ex. IV. A ship from latitude 28° 25′ N. sails south 1800 miles; what latitude is she in?

From diff. of lat. 1800 miles, or	30° 00′	S.
Sub. lat. left	28 25	N.
Diff. = lat. in	1 35	S.

In the last example it is evident that as the difference of latitude is more than the latitude left, the ship must have crossed the equator, and consequently come into south latitude.

NOTE. When one of the places has no latitude, or is on the equator, the latitude of the other place is their difference of latitude.

Ex. V. What is the difference of longitude between Cape Ann light-house and Lisbon?

Cape Ann light-house's long.	70° 34′	W.
Lisbon's long.	9 9	W.
Diff. of long.	61 25	
	60	
In miles	3685	

Ex. VI. A ship from Cape Charles, in Virginia, sails eastward till her difference of longitude is 400 miles; what longitude is she in?

Cape Charles' long.	76° 04′	W.
Diff. of long. 400 miles =	6 40	E.
Long. in	69 24	W.

Ex. VII. What is the difference of longitude between Barcelona and Salem?

Barcelona's long.	2° 12′	E.
Salem's long.	70 52	W.
Diff. of long.	73 4	W.

Ex. VIII. A ship from 15° 40′ E. long. sails westward till her diff. of long. is 27° 15′, what longitude is she in?

Long. left	15° 40′	E.
Diff. of long.	27 15	W.
Long. in	11 35	W.

Ex. IX. What is the difference of longitude between Manilla and New-York light-house?

Manilla's long.	121° 02′	E.
New-York light-house	74 01	W.
Sum exceeds 180°	195 03	
Subtract it from	360 00	
Diff. of long.	164 57	

Ex. X. A ship from longitude 160° 20′ W. sails westward until she differs her longitude 41° 20′; what longitude is she in?

Long. left	160° 20′	W.
Diff. of long.	41 20	W.
	201 40	
	360 00	
Long. in	158 20	E.

In the last example the ship has crossed the opposite meridian, and therefore has come into a longitude of a different name.

PLANE SAILING.

PLANE SAILING is the art of navigating a ship upon principles deduced from the supposition of the earth's being an extended plane, on which the meridians are all parallel to each other.* A map of the several parts of the earth, constructed upon these principles, is called a PLANE CHART. When the parts of the earth are thus delineated on a plane, it is easy to see the track by which a ship may go from one place to another, and also what angle this track makes with the meridian.† Ships at sea are kept in this track by means of an instrument called the mariner's compass.

The MARINER'S Compass is an artificial representation of the horizon of any place. It consists of a circular piece of paper (see Plate VI. fig. 1) called a card, divided (like the horizon) into 360 degrees or 32 points. This is fixed on a piece of steel, called a needle, to which the magnetic virtue has been communicated by means of a loadstone, which has the property of pointing steadily towards the north, and carrying the card with it, when turning freely on a pivot or any thing to support it. Thus all the points of the card will be

* The explanations of Plane Sailing, and the definitions of this page (and in the former editions of this work) are nearly the same as those given by Moore, in his Practical Navigator; by Robertson in his Elements of Navigation, and by most writers on Navigation.

† The method of calculating this angle on the true principles of sailing on the spherical surface of the earth, will be given hereafter.

directed towards their corresponding points of the horizon,* consequently, by help of the compass a ship may be kept in any proposed track or course.

The COURSE is the angle which the line described by a ship makes with the meridian, being sometimes reckoned in points, half points, &c. and sometimes in degrees.

DISTANCE is the way or length a ship has gone on a direct course in a given time. The method of measuring this distance by the log will be explained hereafter.

DIFFERENCE OF LATITUDE is the distance which the ship has made north or south of the place sailed from, or the portion of the meridian contained between the parallels of latitude sailed from and come to.

DEPARTURE is the east or west distance a ship has made from the meridian, or the whole easting or westing made by the ship.

If a ship sails due north or south, she sails on a meridian, makes no departure, and her distance and difference of latitude are the same. If she sails due east or west, she goes on a parallel of latitude, makes no difference of latitude, and her departure and distance are the same.

The difference of latitude and departure make the legs of a right-angled triangle, the hypotenuse of which is the distance the ship has sailed; the perpendicular is the difference of latitude counted on the meridian; the base is the departure, which is easting or westing counted from the meridian; the angle opposite to the base is the course, or angle, that the ship makes with the meridian; and the angle opposite the perpendicular is the complement of the course, which being taken together, make always 8 points or 90 degrees.

In constructing figures relating to a ship's course, let the upper part of the paper, or what the figure is drawn upon, always represent the north; the lower part will be the south; the right hand east, and the left west.

Draw the north and south line to represent the meridian of the place the ship sails from; then, if the ship's course is to the southward, mark the upper end of the line for the place sailed from; but if the course is northward, mark the lower end for that place.

When the course is easterly, describe the arch, and lay off the course and departure on the right hand side of the meridian; but when westerly, on left hand side.

When the course is given in degrees, they must be taken from the line of chords; but when in points, from the line of rhumbs, and must always be laid off upon the arch, beginning at the meridian.

When the course is given in points, the log-sine, log. co-sine, &c. may be found in Table XXV. otherwise in Table XXVII.

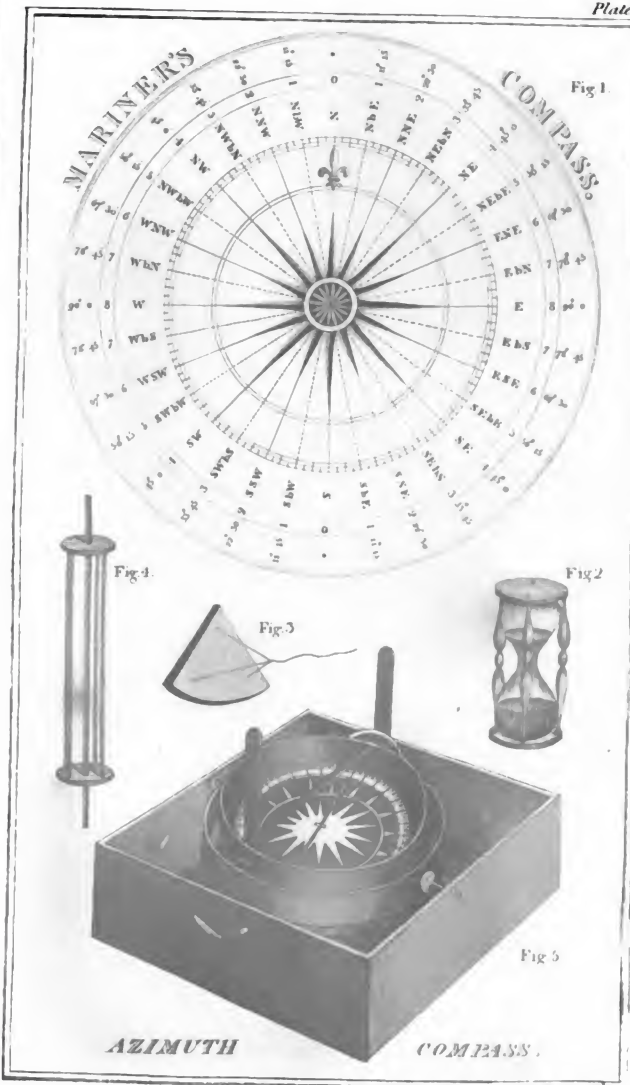
In all cases, where the complement of course, or co-sine, &c. is used, the degrees or points put down, are the course itself, but the logarithms belonging to the complement or co-sine, &c. of that course are taken.

A Table of the Angles which every Point of the Compass makes with the Meridian.

North.	South.	Points	D. M.	North.	South.
		$\frac{1}{4}$	2.49		
		$\frac{1}{2}$	5.37		
		$\frac{3}{4}$	8.26		
N. by E.	S. by E.	1	11.15	N. by W.	S. by W.
		$1\frac{1}{4}$	14. 4		
		$1\frac{1}{2}$	16.52		
		$1\frac{3}{4}$	19.41		
N. N. E.	S. S. E.	2	22.30	N. N. W.	S. S. W.
		$2\frac{1}{4}$	25.19		
		$2\frac{1}{2}$	28. 7		
		$2\frac{3}{4}$	30.56		
N. E. by N.	S. E. by S.	3	33.45	N W. by N.	S. W. by S.
		$3\frac{1}{4}$	36.34		
		$3\frac{1}{2}$	39.22		
		$3\frac{3}{4}$	42.11		
N. E.	S. E.	4	45. 0	N. W.	S. W.
		$4\frac{1}{4}$	47.49		
		$4\frac{1}{2}$	50.37		
		$4\frac{3}{4}$	53.26		
N. E. by E.	S. E. by E.	5	6.15	N W. by W.	S W. by W.
		$5\frac{1}{4}$	59. 4		
		$5\frac{1}{2}$	61.52		
		$5\frac{3}{4}$	64.41		
E. N. E.	E. S. E.	6	67.30	W. N. W.	W. S. W.
		$6\frac{1}{4}$	70.19		
		$6\frac{1}{2}$	73. 7		
		$6\frac{3}{4}$	75.56		
E. by N.	E. by S.	7	78.45	W. by N.	W. by S.
		$7\frac{1}{4}$	81.34		
		$7\frac{1}{2}$	84.22		
		$7\frac{3}{4}$	87.11		
	East.	8	90. 0	West.	

* It is here supposed that the needle points to the true north, but if it varies therefrom, allowance must be made for the variation by the rules which will be given in this work.

Plate VI



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In the following Table, the rules for solving the various cases of Plane Sailing are collected.

PLANE SAILING.

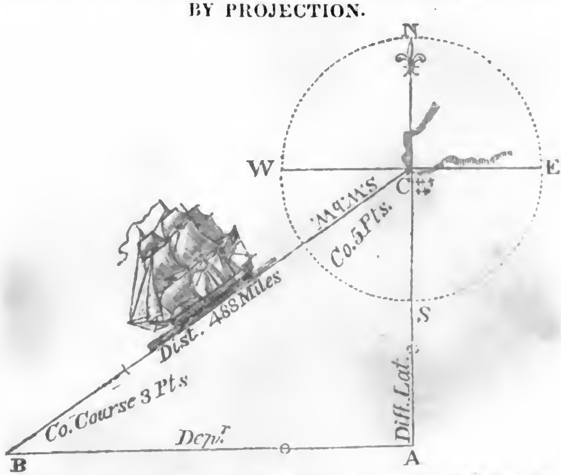
Case	Given.	Required.	Solutions.
1	Course and Distance	Diff. of Lat. Departure.	Rad. : Dist. : : Cos. Course : Diff. of Lat. Rad. : Dist. : : Sine Course : Departure.
2	Course and Diff. of Lat	Distance Departure	Co-sine Course : Diff. Lat. : : Rad. : Distance. Radius : Diff. Lat. : : Tang. Course : Departure.
3	Course and Departure.	Distance Diff. of Lat.	Sine Course : Departure : : Rad. : Distance. Radius : Departure : : Co-tang. Course : Diff. Lat.
4	Distance and Diff. of Lat.	Course Departure	Distance : Radius : : Diff. Lat. : Cos. Course. Radius : Distance : : Sine Course : Departure.
5	Distance and Departure.	Course Diff. of Lat.	Distance : Radius : : Departure : Sine Course. Radius : Distance : : Cos. Course : Diff. Lat.
6	Diff. of Lat. & Departure.	Course Distance.	Diff. Lat. : Radius : : Dep. : Tang. Course. { Sine Course : Departure : : Rad : Distance. { Radius : Diff. Lat. : : Secant Course : Distance.

CASE I.

Course and distance sailed given, to find the difference of latitude and departure from the meridian.

A ship from the latitude of 49° 57′ N. sails S. W. by W. 488 miles; required the latitude she is in, and her departure from the meridian sailed from?

BY PROJECTION.



Draw the line CA to represent the meridian of the place C, from whence the ship sailed. With the chord of 60° in your compasses, and one foot in C as a centre, describe the compass N. W. S. E. Take 5 points in your compasses from the line of rhumbs on the plane scale, and set it off on the arch from S. towards W. for the course; through this point and C draw the line CB, which make equal to the distance 488; draw BA parallel to the E. and W. points W. E. to cut the meridian in A. Then will CA be the difference of latitude 271.1, and AB the departure 405.8.

BY LOGARITHMS.

By making the distance radius.

To find the departure.		To find the difference of latitude.	
As radius 8 points	10.00000	As radius 8 points	10.00000
Is to the distance 488	2.68842	Is to the distance 488	2.68842
So is the sine course 5 points	9.91985	So is co-sine course 5 points	9.74474
To the departure 405.8	2.60827	To the difference of lat. 271.1	2.43316

Now as the ship is in north latitude sailing southerly; from the latitude left 49° 57′ N.
Take the difference of latitude 271.1 = 4 31 S.
Gives the latitude in 45 26 N.

And the departure from the meridian is 405.8 miles.

BY GUNTER.

Extend from radius or 8 points* to 5 points on the line marked SR; that extent will reach from the distance 488 to the departure 405.8 on the line of numbers.

2dly. Extend from radius or 8 points to 3 points, the complement of the course, on the line SR; that extent will reach from the distance 488 to the difference of latitude 271 on the line of numbers.

Thus may all the operations be performed in the several cases of Navigation.

By this case are calculated the tables of latitude and departure (TABLES I. and II.) for every degree, point, and quarter point of the mariner's compass, to the distance of 300 miles. By the inspection of these Tables, a day's work may be calculated in a much more expeditious manner than by logarithms or by Gunter's Scale. In consequence of this, the method by inspection is generally used at sea in preference to every other method.

BY INSPECTION.

Find the given course at the top or bottom of the tables, either among the points or degrees, and in that page, against the distance taken in its column, will stand the difference of latitude and departure in their columns.†

It must be observed, that in using these tables, the names Dist. Lat. Dep. must be found at the top if the course is found there, but if the course is found at the bottom, those names must be found at the bottom.

Thus the course S. W. by W. or 5 points, is found at the bottom of the table of difference of latitude and departure for points; and as the distance 488 is too great to be found in the tables, divide it by 2 (or any other convenient number) and that gives 244, which look for in the distance column, and against it stand 135.5 for the difference of latitude, and 202.9 for the departure, which being doubled (because divided by 2) give 271 for the difference of latitude, and 405.8 for the departure, the same as before.

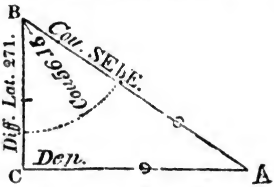
CASE II.

Course and difference of latitude given, to find the distance run, and departure from the meridian.

If a ship runs S. E. by E. from 1° 45′ north latitude, and then by observation is in 2° 46′ south latitude, what is her distance and departure?

In this case, as the ship has crossed the equator, the sum of the two latitudes 1° 45′ and 2° 46′ is the difference of latitude 4° 31′=271 miles.

BY PROJECTION.



Draw BC=271, and BA making an angle with BC equal to the course 5 points, or 56° 15′; draw CA perpendicular to BC to cut BA in A, and it is done; for CA will be the departure=406, and AB the distance=488.

BY LOGARITHMS.

By making diff. of lat. BC radius. To find the departure.		By making the Dep. AB radius.‡ To find the distance.	
As radius 4 points	10.00000	As co-sine course 5 points	9.74474
Is to diff. of lat. 271	2.43297	Is to the diff. of lat. 271	2.43297
So is tang. course 5 pts.	10.17511	So is radius	10.00000
To the departure 405.6	2.60808	To the distance 487.8	2.68823

* When the course is given in points, make use of the lines marked sine rhumbs, and tangent rhumbs, on the upper side of the scale; when in degrees, make use of the lines marked sine and tangent.

† When the distance is too great to be found in the tables, you must divide it by 2, 3, 4, or any convenient number, the numbers corresponding to the quotient being multiplied by the divisor will give the sought numbers.

‡ By making BC radius you would have Rad. : Diff. Lat. : : Secant Course : Distance but this canon would not do for a common scale on which there is no line of secants. The same thing is to be observed in the following cases.

Hence the ship's distance run is 487.8 miles, and her departure from the meridian is 405.6 easterly.

BY GUNTER.

Extend from radius or 4 points to the course 5 points on the line marked TR, that extent will reach from the difference of latitude 271 to the departure 405.6 on the line of numbers.

2dly. Extend from the complement of the course 3 points to the radius 8 points on the line SR, that extent will reach from the difference of latitude 271 to the distance 488 on the line of numbers.

BY INSPECTION.

Find the course among the points or degrees, and the difference of latitude in its column, against which will stand the distance and departure in their columns.

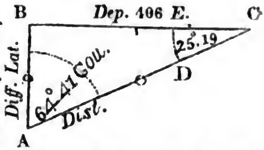
Now, as the difference of latitude 271 is two great to be found in the tables, I divide it by 2, and that gives 135.5 which I find over S. E. by E. or 5 points in the latitude column; against that stand 244, for the distance, and 202.9 for the departure, which multiplied by 2 give the distance 488, and the departure 405.8.

CASE III.

Course and departure from the meridian given, to find the distance and difference of latitude.

If a ship sails N. E. by E. ¾ E. from a port in 3° 15′ south latitude, until she depart from her first meridian 406 miles, I demand the distance sailed, and the latitude she is in?

BY PROJECTION.



Draw the meridian AB, upon which erect the perpendicular BC, and set off thereon the departure 406 easterly from B to C; with the chord of 60°, on C as a centre, describe an arch, and set off thereon the complement of the course DE; through D and C draw the line CDA, cutting the meridian in the point A; then AC measured on the same scale before used, gives the distance 449, and AB 192, the difference of latitude.

BY LOGARITHMS.

By making the departure BC radius.		By making the distance AC radius.	
As radius 4 points	10.00000	As sine course 5¾ pts.	9.95616
Is to the departure 406	2.60853	Is to the departure 406	2.60853
So is co-tang. course 5¾ pts.	9.67483	So is radius	10.00000
To the diff. of lat. 192	2.28336	To the distance 449,1	2.65237

From the latitude left	3° 15′ S.
Subtract the difference of latitude 192 miles, or	3 12 N.
The remainder being 3, shows the ship is in the latitude of	0 3 S.

BY GUNTER.

Extend from radius or 4 points to the co-course 2¼ points on the line marked TR; that extent will reach from the departure 406 to the difference of latitude 192 on the line of numbers.

2dly. Extend from the course 5¾ points to radius on the sines, that extent will reach from the departure 406 to the distance 449 miles on the line of numbers.

BY INSPECTION.

Find the course either among the points or degrees, and the departure in its column, against which will stand the distance and difference of latitude in their respective columns.

Thus with the course 5¾ points, and half the departure 203* I find 224.5 for the distance, and 96.0 for the difference of latitude, which, being doubled, give the distance 449, and the difference of latitude 192.0, as before.

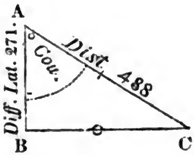
CASE IV.

Distance and difference of latitude given, to find the course and departure.

Suppose a ship sails 488 miles, between the south and the east, from a port in 2° 52′ south latitude, and then by observation is in 7° 23′ south latitude: what course has she steered, and what departure has she made?

From the latitude by observation 7° 23′ take 2° 52′ the latitude left, the remainder 4° 31′=271 miles, is the difference of latitude.

BY PROJECTION.



Draw the meridian AB=271; upon which erect the perpendicular BC; take 488 in your compasses, and with one foot on A, as a centre, describe an arch cutting BC in C; join A and C; then will BC be the departure 406, and the angle BAC the course=56° 16′ or five points nearly.

BY LOGARITHMS.

To find the course.		To find the departure.	
As the distance 488	2.68842	As radius	10.00000
Is to radius	10.00000	Is to the distance 488	2.68842
So is the diff. of lat. 271	2.43297	So is sine course 56° 16′	9.91993
To co-sine course 56° 16′	9.74455	To the departure 405.8	2.60835

Hence the course is S. E. by E. and the departure 405.8.

BY GUNTER.

The extent from the distance 488, to the difference of latitude 271 on the line of numbers, will reach from radius, or 90° to 33° 44′, the co-course on the line of sines.

And the extent from radius, to 56° 16′ on the line of sines, will reach from the distance 488 to the departure 405.8 on the line of numbers.

BY INSPECTION.

Seek in the tables till against the distance taken in its column is found the given difference of latitude in one of the following columns, adjoining to it will stand the departure; which, if less than the difference of latitude, the course is to be found at the top;† but if greater, the course is to be found at the bottom,

Thus half the distance 244, and half the difference of latitude 135.5, are found to correspond to a course of 5 points or S. E. b. E. and to the departure 202.9, which being doubled, gives 405.8, as before.

CASE V.

Distance and departure given, to find the course and difference of latitude.

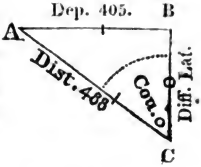
Suppose a ship sails 488 miles between the north and west, from the latitude of 32° 25′ north, until her departure is 405 miles, what course has she steered, and what latitude is she in?

* The nearest numbers in the table are 202.5 and 203.4, and as the number 203 is nearly a mean of these two values, I take the mean 224.5 of the corresponding distances 224, 225. and the mean 96 of the corresponding departures 95.8 and 96.2; these doubled give the true distance 449, and departure 192.

† It may also be known whether the course be marked at the top or bottom of the table, by observing whether the difference of latitude and departure correspond with the marks at the top or bottom. Thus the half distance 244, and half difference of latitude 135.5 correspond to the course 5 points, because the column in which 135.5 is found, is marked latitude at the bottom; the same may be observed in the following cases.

BY PROJECTION.

Draw the line AB equal to the departure 405, and perpendicular thereto the line BC to represent the meridian, then take the distance 488 in your compasses, and fixing one foot in A as a centre, describe an arch cutting BC in C, join AC and it is done; for the angle ACB will be the course, and BC the difference of latitude.



BY LOGARITHMS.

To find the course.		To find the difference of latitude.	
As the distance 488	2.68842	As radius	10.00000
Is to radius	10.00000	Is to the distance 488	2.68842
So is the departure 405	2.60746	So is co-sine course 56° 6′	9.74644
To the sine of course 56° 6′	9.91904	To the diff. of latitude 272,2	2.43486

Hence the course is N. 56° 6′ W. or N. W. by W. nearly.

To the latitude sailed from 32° 25′ add the difference of latitude 272, or 4° 32′, the sum 36° 57′ is the latitude the ship is in.

BY GUNTER.

Extend from the distance 488 to the departure 405 on the line of numbers, that extent will reach from radius to the course 56° 6′ on the line of sines.

2dly. Extend from radius to the complement of the course 33° 54′ on the line of sines, that extent will reach from the distance 488 to the difference of latitude 272 on the line of numbers.

BY INSPECTION.

Seek in the tables till against the distance, taken in its column, is found the given departure in one of the following columns; adjoining to it will stand the difference of latitude; which, if greater than the departure, the course is to be found at the top; but if less, the course is to be found at the bottom.

Thus half the distance 244, and half the departure 202,5, agree nearly to a course of 5 points or N. W. by W. and a difference of latitude 135,5, which being doubled, is 271, the difference of latitude, nearly as before.

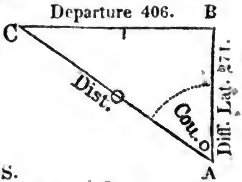
CASE VI.

Difference of Latitude and Departure given to find the Course and Distance.

A ship sails between the north and west till her difference of latitude is 271 miles, and her departure is 406 miles; I demand her course and distance?

BY PROJECTION.

Draw AB=271, and perpendicular to it BC=406; join C and A; then will the angle CAB be the course=56° 17′, and AC the distance=488 miles.



BY LOGARITHMS.

To find the course.		To find the distance.	
As the diff. of latitude 271	2.43297	As radius	10.00000
Is to radius	10.00000	Is to the diff. of latitude 271	2.43297
So is the departure 406	2.60853	So is sec. of course 56° 17′	10.25564
To tang. of course 56° 17′	10.17556	To the distance 488.2	2.68861

Hence her course is N. 56° 17′ W. or N. W. by W. and the distance sailed is 488.2 miles.

BY GUNTER.

Extend from the difference of latitude 271 to the departure 406 on the line of numbers, that extent will reach from radius to 56° 17′ the course on the line of tangents.

2dly. For the distance we must consider it as radius (unless there is a line of secants on the scale) and extend from the course 56° 17′ to the radius or 90° on the line of sines, that extent will reach from the departure 406, to the distance 488 on the line of numbers.

BY INSPECTION.

Seek in the tables till the given difference of latitude and departure are found together in their respective columns, then against them will be the distance in its column, and the course will be found at the top of that table if the departure be less than the difference of latitude, otherwise at the bottom.

Thus with half the difference of latitude 135.5, and half the departure 208, enter the tables, and these numbers will be found to correspond nearly to 5 points or N. W. by W. course, and a distance equal to 244 miles, which being doubled gives the sought distance, 488.

Questions to exercise the learner in the foregoing Rules.

Question I. A ship in 2° 10′ south latitude, sails N. by E. 89 leagues; what latitude is she in, and what is her departure?

Answer. Latitude in 2° 12′ N. and departure 17,36 leagues.

Question II. A ship sails S. S. W. from a port in 41° 30′ north latitude, and then by observation is in 36° 57′ north latitude; I demand the distance run and departure?

Answer. Distance run 98,5 leagues, departure 37,7 leagues.

Question III. A ship sails S. S. W. ½ W. from a port in 2° 30′ south latitude, until her departure be 59 leagues; I demand her distance run and latitude in?

Answer. Distance run 125,2 leagues, latitude in 8° 1′ south.

Question IV. If a ship sail 360 miles south westward from 21° 59′ south latitude, until by observation she be in 24° 49′ south latitude, what is her course and departure?

Answer. The course is S. W. by W. half W. or S. 61° 49′ W. and her departure from the meridian is 317,3 miles.

Question V. Suppose a ship sails 354 miles north eastward from 2° 9′ south latitude, until her departure be 150 miles, what is her course and latitude in?

Answer. Her course is N. 25° 4′ E. or N. N. E. ¼ E. nearly, and she is in latitude 3° 12′ N.

Question VI. Sailing between the north and the west, from a port in 1° 59′ south latitude, and then arriving at another port in 4° 8′ north latitude, which is 209 miles to the westward of the first port—I demand the course and distance from the first port to the second?

Answer. The course is N. 29° 40′ W. or N. N. W. ¾ W. nearly, and the distance of the ports is 422,4 miles, or 140,8 leagues.

Question VII. Four days ago we were in lat. 3° 25′ S. and have since that time sailed in a direct course N. W. by N. at the rate of 8 miles an hour; required our present latitude and departure?

Answer. Latitude in 7° 14′ N. Departure 426,7 miles.

Question VIII. A ship in the latitude of 3° 52′ S. is bound to a port bearing N. W. by W. ½ W. in the latitude of 4° 30′ N. how far does that port lie to the westward, and what is the ship's distance from it?

Answer. The port lies 939,2 miles to the westward, and the direct distance 1065 miles.

Question IX. A ship from the latitude of 48° 17′ N. sails S. W. by S. until she has depressed the north pole 2 degrees; what direct distance has she sailed, and how many miles has she got to the westward?

Answer. Distance run 144,3 miles, and has got to the westward 80,2 miles.

TRAVERSE SAILING.

A TRAVERSE is an irregular track which a ship makes by sailing on several different courses; these are reduced to a single course by means of two or more cases of Plane Sailing, either by geometrical construction, or by arithmetical calculation.*

The geometrical construction is performed as follows: Describe a circle with the chord of 60°, to represent the compass, and lay off on its circumference the various courses sailed. From the centre, upon the first course set off the first distance, and mark its extremity: through this extremity, and parallel to the second course, draw the second distance of its proper length; through the extremity of the second distance, and parallel to the third course, draw the third distance of its proper length; and thus proceed till all the distances are drawn. A line, drawn from the extremity of the last distance to the centre of the circle, will represent the distance made good; a line, drawn from the same point, perpendicular to the meridian, will represent the departure; and the part of the meridian intercepted between this and the centre, will represent the difference of latitude.

The arithmetical calculation to work a traverse is as follows; Make a traverse table consisting of six columns; title them, Course, Dist. N. S. E. W. begin at the left side, and write the given courses and distances in their respective columns. Find the difference of latitude and departure for each of these courses, by Gunter's Scale, or by Tables I. or II. (as in Case I. Plane Sailing) and write them in their proper columns; that is, when the course is southerly, the difference of latitude must be set in the column S. when northerly in the column N. The departure, when westerly, in the column W. and when easterly in the column E. Add up the columns of northing, southing, easting, and westing; take the difference between the northing and southing, and also between the easting and westing; the former difference will be the difference of latitude, which will be of the same name as the greater; and the latter will be the departure, which will be also of the same name as the greater. With this difference of latitude and departure, the course and distance made good are to be found as in Case VI. Plane Sailing.

EXAMPLE I.

Suppose a ship takes her departure from Block Island, in the latitude of 41° 10′ N. the middle of it bearing N. N. W. distance by estimation 5 leagues, and sails S. E. 34, W. by S. 16, W. N. W. 39, and S. by E. 40 miles; required the latitude she is in, and her bearing and distance from Block Island?

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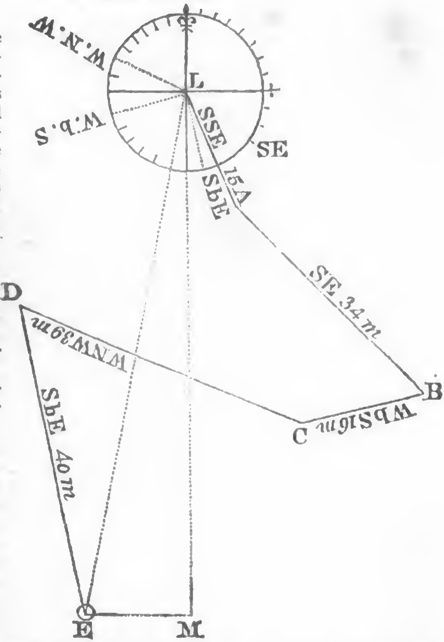
* This method of reducing compound courses to a single one is perfectly accurate in sailing on a plane, and is nearly so in sailing a short distance on the spherical surface of the earth; and though in this case it is liable to a small error in high latitudes, yet in general the rule is sufficiently accurate for reducing the several courses and distances sailed in one day to a single course and distance.

BY PROJECTION.



Let L represent the middle of Block-Island; draw the meridian LM, and on L as a centre, with a chord of 60°, describe a circle to represent the compass, on which mark the various courses sailed, and the bearing of the land at the time of taking the departure; opposite to this bearing draw the S. S. E. line LA, which make equal to 15 miles, the estimated distance of the land; then will A represent the place of the ship at the time of taking the departure: through A draw AB=34 miles parallel to the S. E. line; then will B be the place of the ship after sailing her first course; in like manner draw BC=16 miles parallel to the W. by S. line: CD=39 miles parallel to the W. N. W. line, and DE=40 miles parallel to the S. by E. line; then will E represent the place of the ship after sailing her several courses. Join EL, and draw EM perpendicular to LM; then will LE be the distance of Block-Island 66.8 miles, and the angle ELM=12° 16′ will be the course made good, LM the difference of latitude, and EM the departure.

TO FIND THE SAME BY LOGARITHMS.

For the first course S. S. E. 15 miles.

To find the difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to distance 15	1.17609	Is to distance 15	1.17609
So is co-sine course 2 points	9.96562	So is sine course 2 points	9.58284
To Diff. lat. 13.9	1.14171	To departure 5.7	0.75893

Second course S. E. 34 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 45°	9.84949	Is to sine course 45°	9.84949
So is distance 34	1.53148	So is distance 34	1.53148
To diff. latitude 24	1.38097	To departure 24	1.38097

Third course W. by S. 16 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 78° 45′	9.29024	Is to sine-course 78° 45′	9.99157
So is distance 16	1.20412	So is distance 16	1.20412
To diff. latitude 3.1	0.49436	To departure 15.7	1.19569

Fourth course W. N. W. 39 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 67° 30′	9.58284	Is to sine course 67° 30′	9.96562
So is distance 39	1.59106	So is distance 39	1.59106
To diff. lat. 14.9	1.17390	To departure 36	1.55668

Fifth course S. by E. 40 miles.

For difference of latitude.		For departure.	
As radius 90°	10.00000	As radius 90°	10.00000
Is to co-sine course 11° 15′	9.99157	Is to sine course 11° 15′	9.29024
So is distance 40	1.60206	So is distance 40	1.60206
To diff. lat. 39.2	1.59363	To departure 7.8	0.89230

Though this method of finding the difference of latitude and departure by logarithms is accurate, yet the calculations may be more easily made by the tables of difference of latitude and departure, as in Case I. Plane Sailing.

Place all these courses, distances, &c. in the traverse table, then add up all the westings, eastings, northings, and southings, separately, and set down their respective sums at the bottom of each column; and as the westing is greater than the easting subtract the easting therefrom; the difference 14,2 shews that the ship's departure is so much west of her first meridian.

TRAVERSE TABLE.

Courses.	Dist.	Diff. Lat. N.	Diff. Lat. S.	Departure. E.	Departure. W.
S. S. E.	15		13.9	5.7	
S. E.	34		24.0	24.0	
W. by S.	16		3.1		15.7
W. N. W.	39	14.9			36.0
S. by E.	40		39.2	7.8	
From sum	—	—	80.2	37.5	51.7
Take	—	—	14.9	—	37.5
Rests	—	—	65.3		14.2

Again, the southing being greater than the northing, subtract the northing from it, and the remainder 65.3 shews how far the ship is to the southward of her first place.

To find the direct course or bearing of Block Island from the ship.		To find the distance of the Island.	
As the diff. lat. 65.3	1.81491	As sine of course 12° 16′	9.32728
Is to radius 45°	10.00000	Is to the departure 14,2	1.15229
So is the departure 14.2	1.15229	So is radius 90°	10.00000
To tang. course 12° 16′	9.33738	To the distance 66.8	1.82501

Which, because the difference of latitude is southerly, and the departure westerly, is S. 12° 16′ W. Whence Block Island bears from the ship N. 12° 16′ E. or N. by E. 1° 1′ E.

BY INSPECTION.

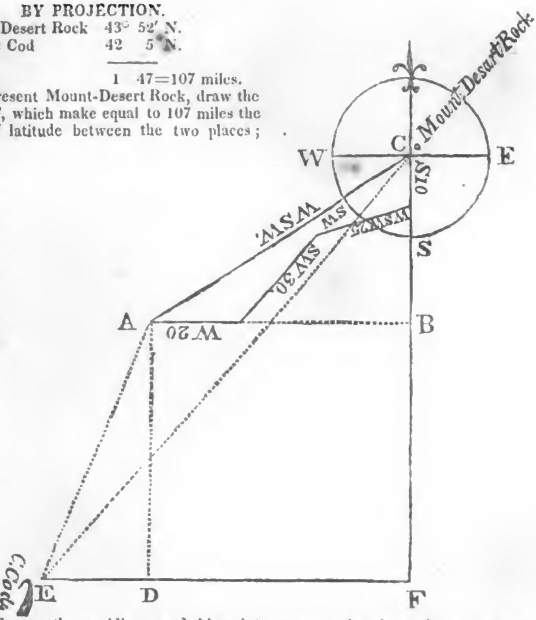
Find the course and distance by Case VI. of Plane Sailing.

EXAMPLE II.

A ship from Mount-Desert Rock, in the latitude of 43° 52′ N. sails for Cape Cod in the latitude of 42° 5′ N. its departure from the meridian of Mount-Desert Rock being supposed to be 84 miles west; but by reason of contrary winds, she is obliged to sail on the following courses, viz. South 10 miles, W. S. W. 25 miles, S. W. 30 miles, and W. 20 miles. Required the bearing and distance of the two places, the course and distance sailed by the ship, and the bearing and distance of her intended port?

BY PROJECTION.

Lat. Mount-Desert Rock	43° 52′ N.
Lat. of Cape Cod	42 5 N.
Diff. of lat.	1 47=107 miles.



Let C represent Mount-Desert Rock, draw the meridian CF, which make equal to 107 miles the difference of latitude between the two places; and perpendicular thereto the line FE equal to the departure 84 miles, then is E the place of Cape Cod. With the chord of 60° sweep about the centre C, a circle E. S. W. to represent the compass, & upon it note the various coursessailed. The first course being South the distance 10 miles is set off from C towards F upon the meridian, and this point represents the place of the ship after sailing her first coure; continue setting off the various courses and distances as in the last example, viz. W. S. W. 25 miles, S. W. 30 miles, and West 20 miles to the point A; then will A represent the place of the ship after sailing these courses. Join CE, AC, AE; draw AB perpendicular to the meridian CF, and AD parallel thereto: then will AC=76,2 miles be the distance made good, AE=69,1 miles the distance of Cape Cod from the ship; CE the distance of the two places=136 miles; ACB=57° 36′, the course made good; EAD=16° 34′ the course to Cape Cod, and ECF the course from Mount-Desert Rock to Cape Cod=38° 8′, &c.

BY LOGARITHMS.

To find the bearing and distance of the two places by Case VI. Plane Sailing.

To find the bearing.		To find the distance.	
As diff. of lat. 107	2.02938	As radius 90°	10.00000
Is to radius 45°	10.00000	Is to diff. of lat. 107	2.02938
So is departure 84	1.92428	So is sec. course 38° 8′	10.10426
To tang. course 38° 8′	9.89490	To the distance 136	2.13364

Whence the course from Mount-Desert Rock to Cape Cod is S. 38° 8′ W. distance 136 miles. The same may be found by the scale or by inspection.

The difference of latitude and departure for the several courses being calculated, by Case I. Plane Sailing, and arranged in the traverse table, it appears that the difference of latitude made good by the ship is 40,8 miles; and the departure 64,3 miles; then by Case VI. Plane Sailing, these numbers are found to correspond to a course of S. 57° 36′, W. and distance 76,2 miles.

TRAVERSE TABLE.

Courses.	Dist.	Diff. Lat.		Departure	
		N.	S.	E.	W.
South.	10		10.0		
W. S. W.	25		9.6		23.1
S. W.	30		21.2		21.2
W.	20				20.0
	Diff.	Lat.	40.8	Dep.	64.3

Subtract the difference of latitude made good by the ship 40,3 miles, from the whole difference of latitude 107 miles, and there remain 66,2 miles, which is the difference of latitude between the ship and Cape Cod. In the same manner by subtracting the ship's departure, 64,3 miles, from the whole departure, 84 miles, there remain 19,7 miles for the departure between the ship and Cape Cod. With this difference of latitude, 66,2, and departure, 19,7, the bearing of Cape Cod is found, by Case VI. Plane Sailing, S. 16° 34′ W. and its distance 69,1 miles.

All the preceding calculations may be made by logarithms, by the scale, or by inspection. But we shall leave them to exercise the learner; and for the same purpose shall add the following example.

EXAMPLE III.

A ship in the latitude of 37° 10′ N. is bound to a port in the latitude of 35° 0′ N. which lies 180 miles west of the meridian of the ship; but by reason of contrary winds she sails the following courses, viz. S. W. by W. 27 miles—W. S. W. ½ W. 30 miles—W. by S. 25 miles—W. by N. 18 miles—S. S. E. 32 miles—S. S. E. ¾ E. 27 miles—S. by E. 25 miles—S. 31 miles, and S. S. E. 39 miles. Required the latitude the ship is in, and her departure from the meridian, with the course and distance to her intended port?

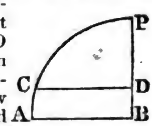
The difference of latitude and departure made on each course, are given in the adjoined traverse table; hence it appears that the difference of latitude made good is 169.4 miles, the departure 47.4 miles, and by Case VI. Plane Sailing, the course S. 15° 38′ W. and distance 175.9 miles; and the course to the intended port S. 58° 42′ W. distance 155.2 miles; the latitude being in 34° 21′ N.

TRAVERSE TABLE.

Courses.	Dist.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. W. by W.	27		15.0		22.4
W.S.W.½W.	30		8.7		28.7
W. by S.	25		4.9		24.5
W. by N.	18	3.5			17.7
S. S. E.*	32		29.6	12.2	
S. S. E. ¾ E.	27		23.2	13.9	
S. by E.	25		24.5	4.9	
South	31		31.0		
S. S. E.*	39		36.0	14.9	
		3.5	172.9	45.9	93.3
			3.5		45.9
	Diff. Lat.		169.4	Dep.	47.4

PARALLEL SAILING.

IN Plane Sailing the earth is considered as an extended plane, but this supposition is very erroneous, because the earth is nearly of a spherical figure, in which the meridians all meet at the poles, consequently the distance of any two meridians measured on a parallel of latitude (which distance is called the meridian distance) decreases in proceeding from the equator to the poles. To illustrate this, let PB represent the semiaxis of the earth, B the centre, P the pole, PCA a quadrant of the meridian, AB the radius of the equator, and CD (parallel thereto) the radius of a parallel of latitude. Then it is evident that CD will be the co-sine of AC or the co-sine of the latitude of the point C, to the radius AB: now if the quadrantal arch PCA be supposed to revolve round the axis PB, the point A will describe the circumference of the equator, and C the circumference of a parallel of latitude; and the former circumference will be to the latter as AB to CD (as may easily be deduced



* Instead of putting the course S. S. E. 32 miles, and S. S. E. 39 miles, you might make one entry only, calling it S. S. E. 71 miles.

from Art. LV. Geometry;) that is, as radius to the co-sine of the latitude or the point C: hence it follows, that the length of any arch of the equator intercepted between two meridians, is to the length of a corresponding arch of any parallel intercepted between the same meridians, as radius is to the co-sine of the latitude of that parallel. Hence we obtain the following theorems.

THEOREM I.

The circumference of the equator is to the circumference of any other parallel of latitude, as radius is to the co-sine of that latitude.

THEOREM II.

As the length of a degree of the equator is to the meridian distance corresponding to a degree on any other parallel of latitude, so is radius to the co-sine of that parallel of latitude.

THEOREM III.

As radius is to the co-sine of any latitude, so are the miles of difference of longitude between two meridians (or their distance in miles upon the equator) to the distance of these two meridians on that parallel of latitude in miles.

THEOREM IV.

As the co-sine of any latitude is to radius, so is the length of any arch on that parallel of latitude (intercepted between two meridians) in miles to the length of a similar arch on the equator, or miles of difference of longitude.

THEOREM V.

As the the co-sine of any latitude is to the co-sine of any other latitude, so is the length of any arch on the first parallel of latitude in miles, to the length of the same arch on the other in miles.

By means of Theorem II. the following Table was calculated, which shows the meridian distance corresponding to a degree of longitude in every latitude: and may be made to answer for any degree or minute by taking proportional parts.

The following Table shews for every degree of latitude how many miles distant the two meridians are, whose difference of longitude is one degree.

D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES.	D. L.	MILES.
1	59. 99	19	56. 73	37	47. 92	55	34. 41	73	17. 54
2	59. 96	20	56. 38	38	47. 28	56	33. 55	74	16. 54
3	59. 92	21	56. 01	39	46. 63	57	32. 68	75	15. 53
4	59. 85	22	55. 63	40	45. 96	58	31. 80	76	14. 52
5	59. 77	23	55. 23	41	45. 23	59	30. 90	77	13. 50
6	59. 67	24	54. 81	42	44. 59	60	30. 00	78	12. 47
7	59. 55	25	54. 38	43	43. 88	61	29. 09	79	11. 45
8	59. 42	26	53. 93	44	43. 16	62	28. 17	80	10. 42
9	59. 26	27	53. 46	45	42. 43	63	27. 24	81	9. 39
10	59. 09	28	52. 98	46	41. 68	64	26. 30	82	8. 35
11	58. 90	29	52. 48	47	40. 92	65	25. 36	83	7. 31
12	58. 69	30	51. 96	48	40. 15	66	24. 40	84	6. 27
13	58. 46	31	51. 43	49	39. 36	67	23. 44	85	5. 23
14	58. 22	32	50. 88	50	38. 57	68	22. 48	86	4. 19
15	57. 96	33	50. 32	51	37. 76	69	21. 50	87	3. 14
16	57. 68	34	49. 74	52	36. 94	70	20. 52	88	2. 09
17	57. 38	35	49. 15	53	36. 11	71	19. 53	89	1. 05
18	57. 06	36	48. 54	54	35. 27	72	18. 54	90	0. 00

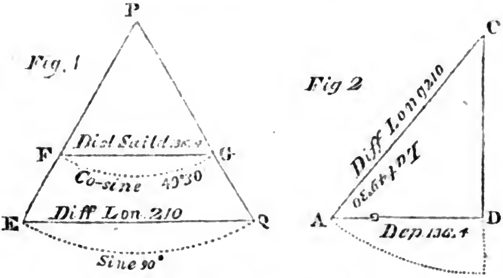
When a ship sails east or west on the surface of the earth supposed to be spherical, she describes a parallel of latitude, and this is called *Parallel Sailing*. In this case, the distance sailed (or departure) is equal to the distance between the meridians sailed from and arrived at in that parallel, and it is easy, by Theorem IV. (preceding) to find the difference of longitude from the distance, or the distance from the difference of longitude, as will appear plain by the following examples.

CASE I.

The difference of longitude between two places in the same parallel of latitude being given, to find the distance between them.

Suppose a ship in the latitude of 49° 30′ north or south, sails directly east or west until her difference of longitude be 3° 30′, required the distance sailed?

BY PROJECTION.



Take the sine of 90° from the Plane Scale, and with one foot of the compasses on P (Fig. 1) as a centre, describe the arch EQ; with the difference of longitude 210 miles in the compasses, and one foot in E, as a centre, describe an arch cutting EQ in Q; join PE, PQ. Take the sine of the complement of the latitude 40° 30′ in your compasses, and with one foot in P, as a centre, describe the arch FG, cutting PE, PQ, in FG; then the length of the chord FG being measured on the scale of equal parts will be the departure 136.4 miles.

Or this projection may be made in the following manner. Draw AD (Fig. 2) of an indefinite length, make the angle DAC equal to the latitude 49° 30′, and AC equal to the difference of longitude 210 miles; draw CD perpendicular to AD; then will the line AD be the distance or departure required.

BY LOGARITHMS.

To find the departure or distance.

As radius 90°	10.00000
Is to the difference of longitude 210	2.32222
So is co-sine latitude 49° 30′	9.81254
To the distance or departure 136,4	2.13476

BY GUNTER.

The extent from radius to the complement of the latitude 40° 30′ on the line of sines, will reach from the difference of longitude 210 to the distance 136,4 on the line of numbers.

BY INSPECTION.

Find the latitude among the degrees in Table II. and in the distance column the difference of longitude, opposite to which in the column of latitude will be the distance required.

In the present example the latitude is 49° 30′, and as the table is only calculated to single degrees, I find the numbers in the tables of 49° and 50°, and take the mean of them; the former is 137,8, the latter 135,0, the mean of which is the sought distance or departure 136,4.

CASE II.

The distance between two places on the same parallel of latitude given, to find their difference of longitude.

Suppose a ship in the latitude of 49° 30′ N. or S. and long. 36° 40′ W. sails directly west 136,4 miles; required the difference of longitude, and longitude in?

BY PROJECTION.

With the sine of the complement of the latitude 40° 30′ in your compasses, and one foot in P, as a centre, (Fig. 1st. of the preceding case) describe the arch FG, upon which set off the departure 136,4 miles upon the chord FG, and through the points F and G draw the lines PE and PQ—then with the sine of 90° in the compasses, and one foot on P as a centre, describe an arch to cut PE, PQ, in E and Q; then the chord EQ being measured upon the same scale of equal parts that the departure was, will be the difference of longitude 210 miles.

Or thus, draw the line AD (Fig. 2d.) which make equal to the given distance 136,4, at D erect DC perpendicular to DA, make the angle DAC equal to the latitude; then will AC be the sought difference of longitude 210 miles.

BY LOGARITHMS.

As co-sine of latitude 49° 30′	9.81254	Long. left	36° 40′ W.
Is to the distance 136,4	2.13481	Diff. long.	3 30 W.
So is radius	10.00000		
		Long. in	40 10 W.
To the diff. of long. 210	2.32227		

BY INSPECTION.

Look for the latitude among the degrees, as if it was a course, and the departure in the column of latitude; against which will stand the difference of longitude in the distance column.

Thus in the course 49°, I seek for 136,4 in the latitude column, and find it corresponds to the distance 208; and in the course 50°, I find it nearly corresponds to 212; half the sum of 208 and 212 is 210, which is the sought difference of longitude.

QUESTIONS TO EXERCISE THE LEARNER.

Question I. A ship in the latitude of 32° N. sails due east till her difference of longitude is 384 miles; required the distance sailed?

Answer. 325.7 miles.

Question II. A ship from the latitude of 53° 39′ S. longitude 10° 18′ E. sails due west 236 miles—required her present longitude?

Answer. 3° 40′ E.

Question III. If two ships in the latitude of 44° 30′ N. distant 216 miles, should sail directly south until they were in the latitude of 32° 17′ N. what distance are they from each other?

Answer. By Theorem V. 256 miles.

Question IV. A ship having run due east for three days, at the rate of 5 knots an hour, finds she has altered her longitude 8° 16; what parallel of latitude did she sail in?

Answer. 43° 28′ N. or S.

MIDDLE LATITUDE SAILING.

IN sailing north or south (or on a meridian) the difference of longitude is nothing, and the difference of latitude is equal to the distance sailed; but in sailing east or west (or on a parallel of latitude) the difference of latitude is nothing, and the difference of longitude may be calculated by the foregoing Theorems of Parallel Sailing. In sailing on any other course, the ship changes both her latitude and longitude; in this case, the difference of latitude, departure, and difference of longitude may be calculated by a proper application of the principles of Plane Sailing to the sailing on a spherical surface; to do which, the surface of the globe may be supposed to be divided into an indefinite number of small surfaces, as square miles, furlongs, yards, &c. which on account of their smallness, in comparison with the whole surface of the earth, may be esteemed as plane surfaces, and the difference of latitude and departure (or meridian distance) made in sailing over each of these surfaces, may be calculated by the common rules of Plane Sailing, and by summing up all the differences of latitude and departures made on these different planes, we shall obtain the whole difference of latitude and departure nearly.* Now, by Case I. of Plane Sailing, the distance described on any one of these small surfaces is to the corresponding difference of latitude as radius is to the co-sine of the course, and as the course is

* The error arising from this supposition will be decreased by increasing the number of the planes, so that, by increasing the number indefinitely, the error may be made less than any assignable quantity.

the same on all these surfaces, it follows that the sum of all the distances described thereon is to the sum of the corresponding differences of latitude as radius is to the co-sine of the course; that is, the whole distance sailed on the globe is to the corresponding difference of latitude as radius is to the co-sine of the course. In a similar manner it appears, that the distance described on the globe is to the sum of all the corresponding departures (or meridian distances) described on these different surfaces, as radius is to the sine of the course. So that the canons for calculating the whole difference of latitude and departure from the course and distance are the same, whether the earth be esteemed as an extended plane or a spherical surface, and the same is to be observed with respect to the other cases of Plane Sailing.

We shall, therefore, in all the calculations of sailing on the spherical surface of the earth, in which the course, distance, difference of latitude and departure occur, make use of the canons already taught in Plane Sailing, and shall construct the schemes exactly in the same manner. The only additional calculation in sailing on a spherical surface consists in determining the longitude from the departure: for in sailing on a plane, the departure and longitude are the same, but in sailing on a spherical surface, *the whole departure (as was observed above) is equal to the sum of all the meridian distances made in sailing over the indefinite number of small surfaces, into which we have supposed the spherical surface to be divided, and the whole difference of longitude corresponding is equal to the sum of all the differences of longitude, deduced from each of these small meridian distances by Theorem IV. of Parallel Sailing.** Several methods have been proposed for abridging the calculation of the difference of longitude from the departure, the most noted of which are those known by the names of *Middle Latitude Sailing* and *Mercator's Sailing*, the latter (which will be hereafter explained) is perfectly accurate,† the former is only an approximation, but it is very much used in calculating short runs and days works, but in calculating large distances across distant parallels it is liable to error. The principle on which the calculations of Middle Latitude Sailing is founded, is this:—Instead of calculating the difference of longitude corresponding to the departure made on each of the small surfaces, into which we have supposed the sphere to be divided, and adding them together, the whole departure (or sum of the meridian distances) is calculated, and the longitude deduced therefrom by the rules of Parallel Sailing, using for the latitude the arithmetical mean between the latitude sailed from and that arrived to. On this supposition, we have the two first of the following theorems for calculating the departure from the difference of longitude, or the difference of longitude from the departure, which are the same as Theo. III. and IV. of Parallel Sailing, except in writing departure for distance, and middle latitude for latitude: the other theorems are easily obtained by combining the two first with the common theorems of Plane Sailing: *observing that the Middle Latitude is half the sum of the two latitudes, if they are of the same name, or half their difference if of contrary names.*

THEOREM I.

As radius is to the co-sine of the middle latitude, so is the difference of longitude to the departure.

THEOREM II.

As the co-sine of the middle latitude is to the radius, so is the departure to the difference of longitude.

Now by case I. of Plane Sailing, the radius is to the sine of the course, as the distance sailed is to the departure, and, if we combine this analogy with Theorem II. we shall have,

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* Using (in estimating the difference of longitude corresponding to each of these small meridian distances) the latitude corresponding to the middle point of the surface on which these small meridian distances are respectively made.

† This is true in theory, and would be so in practice, if the meridional difference of latitude in Table III. were given to a sufficient number of decimals, but being only given to the nearest mile or minute, the error arising from this cause, when the difference of latitude is small, is greater than the error in middle latitude sailing; in consequence of this, the method by middle latitude is almost exclusively used in the common operations on shipboard.

THEOREM III.

As the co-sine of the middle latitude is to the sine of the course, so is the distance sailed to the difference of longitude.

By Case II. of Plane Sailing, we have this analogy; as radius is to the tangent of the course, so is the difference of latitude to the departure; by combining this with Theorem II. we have

THEOREM IV.

As the co-sine of the middle latitude is to the tangent of the course, so is the difference of latitude to the difference of longitude.

Whence we easily deduce the following,

THEOREM V.

As the difference of latitude is to the difference of longitude, so is the co-sine of the middle latitude to the tangent of the course.

By means of the preceding theorems we have formed the following Table, which contains all the rules necessary for solving the various cases of Middle Latitude Sailing.

MIDDLE LATITUDE SAILING.

Case.	Given.	Sought.	SOLUTION.
1	Both Latitudes and Longitude.	Departure.	Rad. : Diff. Long. : : Co-sine Mid. Lat. : Dep.
		Course.	{ Diff. Lat. : Rad. : : Dep. : Tang. Course. { Diff. Lat. : Diff. Long. : : Cos. Mid. Lat. : Tang. Course.
		Distance.	{ Rad. : Diff. Lat. : : Secant Course : Distance. { Sine Course : Depart. : : Rad. : Distance.
2	Both Latitudes and Departure.	Course.	Diff. Lat. . Rad. : : Dep. : Tang. Course.
		Distance.	Sine Course : Dep. : : Rad. : Distance.
		Diff. Long.	Co sine Mid. Lat. : Dep. : : Rad. : Diff. Long
3	One Latitude, Course and Distance.	Diff. Lat.	Rad. : Dist. : : Co-sine Course : Diff. Lat. Hence the other Latitude and Middle Latitude are found.
		Departure.	Rad. : Dist. : : Sine Course : Departure.
		Diff. Long.	{ Co-Sine Mid. Lat. : Dep. : : Rad. : Diff. Long. { Co-Sine Mid. Lat. : Sine Course : : Dist. : Diff. Long.
4	Both Latitudes and Course.	Departure.	Rad. : Diff. Lat. : : Tang. Course : Departure.
		Distance.	Co-sine Course : Diff. Lat. : : Rad. : Distance.
		Diff. Long	{ Co-sine Mid. Lat. : Dep. : : Rad. : Diff. Long. { Cos. Mid. Lat. : Tang. Course : : Diff. Lat. : Diff. Long.
5	Both Latitudes and Distance.	Course.	Dist. : Rad. : : Diff. Lat. : Co-sine Course.
		Departure.	Rad. : Dist. : : Sine Course : Departure.
		Diff. Long	Co-sine Mid. Lat. : Dep. : : Rad. : Diff. Long.
6	One Latitude, Course and Departure.	Diff. Lat.	Rad. : Dep. : : Co-tang. Course : Diff. Lat. Hence the other Latitude and Middle Latitude are known.
		Distance.	Sine Course : Departure : : Rad. : Distance.
		Diff. Long.	Co-sine Mid. Lat. : Dep. : : Rad. : Diff. Long.
7	One Latitude, Distance and Departure.	Course.	Dist. : Rad. : : Dep. : Sine Course.
		Diff. Lat.	Rad. : Dist. : : Co-sine Course : Diff. Lat. Hence we obtain the other latitude and middle latitude.
		Diff. Long.	Co-sine Mid. Lat. : Dep. : : Rad. : Diff. Long.

We shall now proceed to illustrate these rules, by working an example in every case.

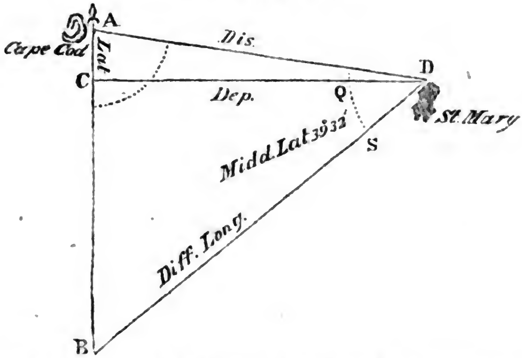
CASE I.

The latitudes and longitudes of two places given, to find their bearing and distance.

Required the bearing and distance between Cape Cod light-house, in the latitude of 42° 5′ N. longitude 70° 4′ W. and the island of St. Mary, (one of the Western Islands) in the latitude of 36° 59′ N. and longitude 25° 10′ W.

Cape Cod's lat.	42° 5′ N.		42° 5′	Long.	70° 4′ W.
St. Mary's lat.	36 59 N.		36 59	Long.	25 10 W.
Diff. lat.	5 6	Sum	79 4		44 54
	60				60
		Mid. lat.	39 32		
In miles	306			Diff. long.	2694 miles.

BY PROJECTION.



Draw the east and west line DC, with the chord of 60° describe the arch QS about the centre D, to cut DC in Q; upon this arch, set off, from Q to S, the middle latitude 39° 32′; through D and S draw the line DB, which make equal to the difference of longitude 2694 miles; from B let fall upon DC the perpendicular BC, which continue towards A making AC equal to the difference of latitude 306 miles;* join AD, and it is done. For by this method of construction, on the principles before explained, A will be the situation of Cape Cod, D the situation of St. Mary; CD will be the departure, which being measured will be found to be 2078 miles; the distance will be represented by AD, which being measured will be found to be 2099 miles, and the course from Cape Cod to St. Mary, will be represented by the angle CAD=81° 37′; therefore the course will be S. 81° 37′ E. or E. ¾ S. nearly.

NOTE. The course is put S. 81° 37′ E. because St. Mary being in a less northern latitude than Cape Cod, is to the southward of it; it is also to the eastward of Cape Cod, because it is in a less western longitude.

BY LOGARITHMS.

To find the departure (by Theorem I.)

As radius 90°	10.00000
Is to diff. of long. 2694	3.43040
So is co-sine mid. lat. 39° 32′	9.88720
To the departure 2078	3.31760

To find the distance.

As radius 90°	10.00000
Is to the diff. of lat. 306	2.48572
So is sec. of course 81° 37′	10.83626
To the distance 2099	3.32198

NOTE. The log. of the departure above found 3.31760 is rather less than the log. of 2078=3.31765; but in finding the course by the departure, I have used the quantity found at the first operation, and shall do the same in all future calculations.

To find the course.

As diff. of lat. 306	2.48572
Is to radius 45°	10.00000
So is the departure 2078	3.31760
To tang. of course 81° 37′	10.83188

NOTE. The course may be found without the departure, by Theo. V. Middle Latitude Sailing.

As the diff. of lat. 306	2.48572
Is to the diff. of long. 2694	3.43040
So is co-sine mid. lat. 39° 32′	9.88720
	13.31760
	2.48572
To tang. of course 81° 37′	10.83188

BY GUNTER.

Extend from the radius or 90° to 50° 28′ the complement of the middle latitude, on the line of sines; that extent will reach from the difference of longitude 2694, to the departure 2078, on the line of numbers.

2dly. Extend from the difference of latitude 306, to the departure 2078,

* If the place A be to the southward of D, the line AC should be set off upon the line CB, from C towards B.

on the line of numbers; that extent will reach from radius or 45°, to the course 81° 37′ on the line of tangents.

3dly. Extend from the course 81° 37′ to the radius 90° on the line of sines, that extent will reach from the departure 2078 to the distance 2099 miles on the line of numbers.

BY INSPECTION.

Rule. Look for the middle latitude, as if it was a course in Plane Sailing, and the difference of longitude in the distance column, opposite to which, in the column of latitude, will stand the departure; having the difference of latitude and departure, the course and distance are found (as in Case VI. Plane Sailing) by seeking in Tab. II. with the difference of latitude and departure, until they are found to agree in their respective columns; opposite to them will be found the distance in its column, and the course will be found at the top of that table, if the departure be less than the difference of latitude, otherwise at the bottom.

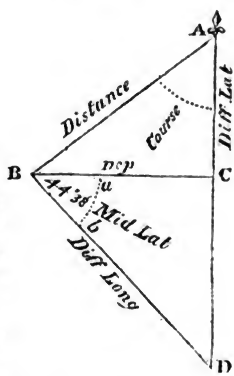
Thus with one tenth of the difference of longitude 269.4 or 269, I enter Table II. and opposite to it, in the distance column of the Tables of 39° and 40°, I find 209.1 and 206.1 in the latitude column; now the middle latitude being nearly 39½°, I take the mean of these, 207.6 for the departure, which being multiplied by 10, gives the whole departure 2076. Again, I enter Table I, with one tenth of the departure 207.6, and one tenth of the difference of latitude 30.6 and find that they agree nearly to a course of 7¼ points, and a distance of 210, which multiplied by 10, gives the sought distance 2100 miles nearly.

CASE II.

Both latitudes and departure from the meridian given, to find the course, distance, and difference of longitude.

A ship in the latitude of 49° 57′ N. and longitude of 15° 16′ W. sails south-westerly till her departure is 789 miles, and latitude in 39° 20′ N. Required the course, distance and longitude in?

Latitude left	49° 57′ N.
Latitude in	39 20 N.
Diff. of lat.	10 37=637 miles.
Sum of lats.	79 17
Middle lat.	44 38



BY PROJECTION.

Draw the meridian ACD, on which take AC equal to the difference of latitude 637 miles; draw CB perpendicular to AC, and make it equal to the departure 789 miles; about B as a centre describe an arch ab, on which set off the middle latitude 44° 38′; through B and b draw the line BD, meeting ACD in D; join AB and it is done; for AB will be the distance sailed, which being measured will be found=1014 miles; BD will be the difference of longitude =1109 miles, and the angle CAB will represent the course from the meridian 51° 5′.

BY LOGARITHMS.

To find the course.		To find the distance.	
As the diff. of lat. 637	2.80414	As sine course 51° 5′	9.89101
Is to radius 45°	10.00000	Is to the departure 789	2.89708
So is the departure 789	2.89708	So is radius 90°	10.00000
To tang. course 51° 5′	10.09294	To the distance 1014	3.00607
To find the difference of longitude.			
As co-sine mid. latitude 44° 38′	9.85225	Longitude sailed from	15° 16′ W.
Is to the departure 789	2.89708	Diff. Long. 1109 miles	18 29 W.
So is radius 90°	10.00000	Longitude in	33 45 W.
To diff. of long. 1109	3.04483		

BY GUNTER.

1st. The extent from the difference of latitude 637 to the departure 789, on the line of numbers, will reach from radius, or 45°, to the course 51° 5′ on the line of tangents.

2dly. The extent from 51° 5′ to radius, or 90°, on the line of sines, will reach from the departure 789, to the distance 1014 on the line of numbers.

3dly. The extent from the complement of middle latitude 45° 22′, to radius, or 90°, on the line of sines, will reach from the departure 789 to the difference of longitude 1109 on the line of numbers.

BY INSPECTION.

Rule. With the difference of latitude and departure, find the course and distance (as in Case VI. of Plane Sailing) by seeking in Tab. II. until the difference of latitude and departure are found to correspond, against which in the distance column will be the distance; and if the departure be less than the difference of latitude, the course will be found at the top of that table, otherwise at the bottom.

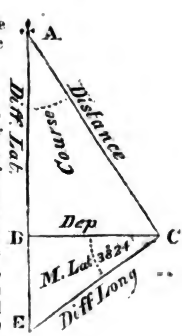
Then take the middle latitude as a course, and find the departure in the latitude column, the number corresponding in the distance column will be the difference of longitude.

In the present example, I take one tenth of the difference of latitude 637, and the departure 789; that is 63,7 and 78,9 the nearest numbers to these are 63,6 and 78,5, standing together over 51°, against the distance 101, which being multiplied by 10 gives 1010; whence the course by inspection is S. 51° W. and the distance 1010. Then I take one tenth of the departure, 78,9 and seek it in the column of latitude of 45° (which is the nearest to the middle latitude 44° 38′), the nearest number I find is 79.2, opposite which in the distance column stands 112, which being multiplied by 10 gives 1120 for the difference of longitude; this value differs a little from that found by logarithms, owing to the miles of middle latitude neglected, for if we were also to find the difference of longitude for the middle latitude 44° and proportion for the minutes, the result would come out nearly the same as by logarithms.

CASE III.

One latitude, course and distance given, to find the difference of latitude and difference of longitude.

A ship in the latitude of 42° 30′ N. and longitude 58° 51′ W. sails S. E. by S. 591 miles. Required the latitude and longitude in?



BY PROJECTION.

Draw the meridian ADE (as in case I. Plane Sailing) upon A as a centre describe an arch with the chord of 60°, and upon it set off, from where it cuts AD, the course S. E. by S. or 3 points, through that point of the arch, and the point A, draw the line AC, which make equal to the distance 591 miles; from C let fall upon AD the perpendicular CD; then will CD be the departure 328 miles, and AD the difference of latitude 491 miles. Hence we obtain the latitude arrived at, and the middle latitude; draw the line CE making an angle with DC of 38° 24′=the middle latitude; and the distance CE will be the difference of longitude 419 miles, hence the longitude in is obtained.

BY LOGARITHMS.

To find the difference of latitude.		To find the departure.	
As radius 8 pts.	10.00000	As radius 8 pts.	10.00000
Is to the distance 591	2.77159	Is to the distance 591	2.77159
So is co-sine course 3 pts.	9.91985	So is sine course 3 pts.	9.74474
To the diff. of lat. 491.4	2.69144	To the departure 328.3	2.51633
Latitude left 42° 30′ N.		To find diff. long. with departure.	
Diff. of lat. 8 11 S.		As co-sine mid. lat. 38° 24′	9.89415
Latitude in 34 19 N.		Is to the departure 328.3*	2.51633
Sum of lats. 76 49		So is radius 90°	10.00000
Middle lat. 38 24		To diff. of long. 419 miles	2.62218
Long. left 58° 51′ W.		Without the departure.	
Diff. of long. 419=6 59 E.		As co-sine mid. lat. 38° 24′ ar. co.	0.10585
Longitude in 51 52 W.		Is to sine course 3 pts.	9.74474
		So is distance 591	2.77159
		To diff. of long. 419 miles	2.62218

BY GUNTER.

1st. The extent from radius 8 points to the complement of the course 5 points on the line marked SR, will reach from the distance 591 to the difference of latitude 491 on the line of numbers.

2dly. The extent from radius 8 points to the course 3 points on the line SR, will reach from the distance 591 to the departure 328 on the line of numbers.

3dly. The extent from the complement of middle latitude 51° 36′ to radius 90° on the line of sines, will reach from the departure 328 to the difference of longitude 419 on the line of numbers.

BY INSPECTION.

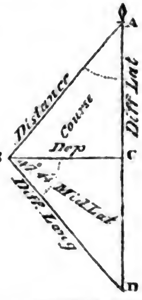
Rule. With the course and distance find the difference of latitude and departure (as in Case I. of Plane Sailing) by finding the given course at the top or bottom of the Tables, either among the points or degrees; in that page and opposite the distance taken in its column, will stand the difference of latitude and departure in their columns. Then take the middle latitude as a course and find the departure in the latitude column, against it, in the distance column will stand the difference of longitude.

Thus, under the course three points, or S. E. by S. and against the tenth of the distance 591=59,1 or 59 stand 49,1 and 32,8; these multiplied by 10 give 491 for the difference of latitude and 328 for the departure. Now taking the middle latitude 38° 24′ or 38° as a course, and a tenth of the departure 328=32,8 in the column of difference of latitude (the nearest is 33,1) against which stands 42 in the distance column; this multiplied by 10 gives 420 for the difference of longitude nearly.

CASE IV.

Both latitudes and course given, to find the departure, distance and difference of longitude.

Suppose a ship sailing from a place in the latitude of 49° 57′ N. and longitude of 30° W. makes a course good of S. 39° W. and then by observation is in the latitude of 45° 31′ N.—it is required to find the distance run, and longitude in?



Latitude from	49° 57′ N.
Lat. by observation	45 31 N.
	4 26
	60
Diff. lat.	266
Sum of lats.	95° 28′
Mid. lat.	47 44

* The logarithm of the departure was found by the preceding canon to be 2.51633, differing a little from the logarithm of 328.3.

BY PROJECTION.

Draw the meridian ACD, on which set off AC equal to the difference of latitude 266 miles; draw CB perpendicular to AC; draw the line AB, making an angle equal to the course 39° with AC, and meeting BC in B; through B draw BD, making an angle equal to the middle latitude 47° 44′ with the line BC, and it is done; for AB will be the distance 342.3 miles, BC the departure 215.4 miles, and BD the difference of longitude 320.3 miles.

BY LOGARITHMS.

To find the departure.

As radius 45°	10.00000
Is to the diff. of lat. 266	2.42488
So is tang. course 39°	9.90837
To the departure 215.4	2.33325

To find the distance.

As co-sine of the course 39°	9.89050
Is to the diff. of lat. 266	2.42488
So is radius 90°	10.00000
To the distance 342.3	2.53438

To find the longitude in.

Longitude sailed from	30°	0′ W.
Diff. long. 320 miles or	5	20 W.
Longitude in	35	20

To find the difference of longitude by the departure.

As co-sine mid. lat. 47° 44′	9.82775
Is to the departure 215.4	2.33325
So is radius 90°	10.00000
To the diff. of long. 320.3	2.50550

The diff. of long. may be found without the departure, by Theo IV. mid. lat. sailing, thus:

As co-sine mid. lat. 47° 44′	9.82775
Is to tang. of course 39°	9.90837
So is the diff. of lat. 266	2.42488
	12.33325
	9.82775
To the diff. of long. 320.3	2.50550

BY GUNTER.

1st. The extent from radius 45° to the course 39° on the line of tangents, will reach from the difference of lat. 266 to the departure 215.4 on the line of numbers.

2dly. The extent from the complement of the course 51° to the radius 90° on the line of sines, will reach from the difference of latitude 266 to the distance 342.3 on the line of numbers.

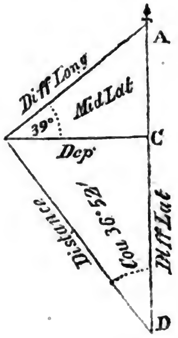
3dly. The extent from the complement of the middle latitude 42° 16′ to radius 90° on the line of sines, will reach from the departure 215.4 to the difference of longitude 320.3 on the line of numbers.

BY INSPECTION.

Find the course among the points or degrees (in Tab. I. or II. as in Case II. Plane Sailing) and the difference of latitude in its column, against which will stand the distance and departure in their columns; then take the middle latitude as a course, and find the departure in the latitude column, against which, in the distance column, will stand the difference of longitude.

Thus, with the course 39°, and half the difference of latitude 133, I enter Table II. the nearest number in the table is 132.9, which corresponds to the distance 171, and to the departure 107.6; these doubled give the distance 342, and the departure 215,2 miles.

Then with the mid. lat. 47° 44′ or 48° as a course, I enter Table II. and seek for half the departure 107.6 in the lat. col. the nearest number to which is 107.7, which corresponds to the distance 161; this doubled gives the diff. of long. 322 miles nearly.



CASE V.

Both latitudes and distance given, to find the course, departure, and difference of longitude.

Suppose a ship sails 300 miles north-westerly, from a place in the latitude of 37° N. and the longitude of 32° 16′ W. until she is in the latitude of 41° N.—required her course and longitude in?

Latitude left	37° 0′ N.			37°	0′ N.
Latitude in	41 0			41	0
	4 0		Sum	78	0
	60		Mid. lat.	39	0
Diff. lat.	240				

BY PROJECTION.

Draw the meridian ACD, on which set off DC equal to the difference of latitude 240 miles; draw the line CB perpendicular to DC; take the distance 300 in your compasses, and with one foot in D, as a centre, sweep an arch cutting CB in B; join DB; make the angle CBA equal to the middle latitude 39° and draw BA cutting DCA in A, and it is done; for BC will be the departure 180 miles, BA the difference of longitude 231.6 miles, and the angle BDC will represent the angle of the ship's course with the meridian, which will therefore be N. 36° 52′ W.

BY LOGARITHMS.

To find the course.	
As the distance 300	2.47712
Is to radius 90°	10.00000
So is diff. lat. 240	2.38021
To co-sine course 36° 52′	9.90309
To find the departure.	
As radius 90°	10.00000
Is to the distance 300	2.47712
So is sine course 36° 52′	9.77812
To the departure 180.0	2.25524

To find the difference of longitude by the departure.	
As co-sine mid. lat. 39°	9.89050
Is to the departure 180.0	*2.25524
So is radius 90°	10.00000
To diff. of long. 231.6	2.36474
To find the longitude in.	
Longitude left	32° 16′ W.
Diff. of long.	3 52 W.
Longitude in	36 8 W.

BY GUNTER.

1st. The extent from the distance 300 to the difference of latitude 240 on the line of numbers, will reach from radius 90° to the complement of the course=53° 8′, on the line of sines.

2dly. The extent from radius 90° to the course 36° 52′ on the line of sines, will reach from the distance 300 to the departure 180 on the line of numbers.

3dly. The extent from the complement of the middle latitude 51° to the radius 90° on the line of sines, will reach from the departure 180 to the difference of longitude 231.6 on the line of numbers.

BY INSPECTION.

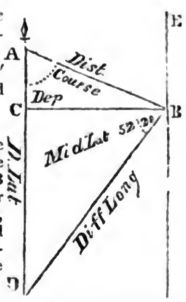
Find the course (as in Case IV. Plane Sailing) by seeking in Table II. till against the distance taken in its column, is found the difference of latitude in one of the following columns; adjoining to it will stand the departure; which if less than the difference of latitude, the course is to be found at the top of the Table, but if greater, at the bottom; then take the middle latitude as a course, and find the departure in the column of difference of latitude, against which, in the distance column, will stand the difference of longitude.

Thus the distance 300, and the difference of latitude 240, are found to correspond nearly to a course of 37°, and a departure of 180.5: then taking the middle latitude 39° as a course, I seek the departure 180.5 in the latitude column, corresponding to which, in the distance column, is the difference of longitude 232.

CASE VI.

One latitude, course, and departure given, to find the difference of latitude, distance, and difference of longitude.

A ship in the latitude of 50° 10′ S. and longitude of 30° 00′ E. sails E. S. E. until her departure is 957 miles; required her distance sailed, and latitude and longitude in?



BY PROJECTION.

Draw the meridian ACD, and parallel thereto at a distance equal to the departure 957 miles, draw the line EB; make the angle CAB equal to the course 6 points, and draw AB meeting EB in B; from B let fall upon AD the perpendicular BC; then will AC be the difference of latitude 396.4 miles, and AB the distance sailed 1036 miles; having thus obtained the middle latitude 53° 28′, make the angle CBD equal thereto, and draw BD meeting ACD in D; then will BD be the difference of longitude 1608 miles.

* This logarithm, by the preceeding operation, was found equal to 2.25524, differing a little from the logarithm of 180.0.

BY LOGARITHMS.

To find the diff. of latitude.		To find the distance.	
As radius 4 points	10.00000	As sine course 6 points	9.96562
Is to the departure 957	2.98091	Is to the departure 957	2.98091
So is co-tang. course 6 points	9.61722	So is radius 8 points	10.00000
To the diff. of lat. 396,4	2.59813	To the distance 1036	3.01529
Latitude left	50° 10′ S.	To find the diff. of longitude.	
Diff. of lat. 396 miles	6 36 S.	As co-sine mid. lat. 53° 28′	9.77473
Latitude in	56 46 S.	Is to the departure 957	2.98091
Sum of latitudes	106 56	So is radius 90°	10.00000
Middle latitude	53 28	To the diff. of long. 1608	3.20618

Longitude left		30° 00′ E.
Diff. of long. 1608	=	26 48 E.
Long. in		56 48 E.

BY GUNTER.

1st. The extent from the course 6 points to the radius 4 points, on the line marked TR, will reach from the departure 957, to the difference of latitude 396,4 on the line of numbers.

2dly. The extent from 6 points to the radius or 8 points, on the line marked SR, will reach from the departure 957, to the distance 1036, on the line of numbers.

3dly. The extent from the complement of the middle latitude 36° 32′ to the radius 90°, on the sines, will reach from the departure 957, to the difference of longitude 1608, on the line of numbers.

BY INSPECTION.

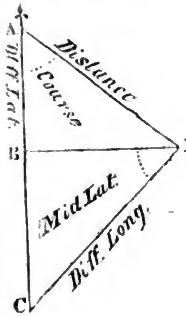
Find the course among the points or degrees, Tab. I. or Tab. II. (as in Case III. Plane Sailing) and the departure in its column, corresponding to which, in the columns of distance and difference of latitude, will be found the distance and difference of latitude respectively; then with the middle latitude as a course, seek the departure in the column of latitude, corresponding to which, in the distance column, will stand the difference of longitude.

Thus, I enter Table I. above E. S. E. or 6 points, and seek for one-tenth of the departure 95,7, the nearest to which is 96,1, and the corresponding numbers are 104 and 39,8, which multiplied by ten gives the distance 1040 and the difference of latitude 398 nearly; the middle latitude being nearly 53½°, I seek in the Table of 53° for the distance corresponding to a tenth of the departure=95,7 and find it to be 159; then I seek for the same number 95,7 in the Table of 54°, and find the number corresponding in the distance column to be 163, half the sum of these two numbers is 161, which multiplied by 10 gives the difference of longitude 1610 nearly.

CASE VII.

One latitude, distance sailed, and departure from the meridian given, to find the course, difference of latitude, and difference of longitude.

A ship in the latitude of 49° 30′ N. and longitude of 25° 0′ W. sails south-easterly 645 miles until her departure from the meridian be 500 miles; required the course steered, and the latitude and longitude the ship is in?



BY PROJECTION.

Draw the line BD equal to the departure 500 miles, and perpendicular thereto draw the meridian line ABC; take an extent equal to the distance 645 in your compasses, and with one foot in D as a centre, describe an arch cutting AB in A, join AD, then will AB be the difference of latitude 407,5 miles, and BAD the course, S. 50° 49′ E. Hence we have the latitude in, and middle latitude; make the angle BDC equal to the middle latitude and draw DC cutting ABC in C, then DC will be the difference of longitude 721,1 miles.

BY LOGARITHMS.

To find the course.			
As the distance 645	2.80956	Latitude left	49° 30′ N.
Is to radius 90°	10.00000	Diff. of lat. 408	6 48 S.
So is the departure 500	2.69897	Latitude in	42 42 N.
To sine-course 50° 49′	9.88941	Sum of the latitudes	92 12
To find the difference of latitude.		Middle latitude	46 6
As radius 90°	10.00000		
Is to the distance 645	2.80956		
So is co-sine course 50° 49′	9.80058		
To the diff. of lat. 407.5	2.61014		
To find the difference of longitude.		Longitude left	25° 0′ W.
As co-sine mid. lat. 46° 6′	9.84098	Diff. long. 721	12 1 E.
Is to the departure 500	2.69897		
So is radius 90°	10.00000	Longitude in	12 59 W.
To the diff. of long. 721.1	2.85799		

BY GUNTER.

1st. The extent from the distance 645, to the departure 500, on the line of numbers, will reach from the radius 90°, to the course 50° 49′ on the line of sines.

2dly. The extent from radius 90°, to the complement of the course 39° 11′, on the line of sines, will reach from the distance 645 to the difference of latitude 407,5 on the line of numbers.

3dly. The extent from the complement of the middle latitude 43° 54′, to the radius 90° on the line of sines, will reach from the departure 500, to the difference of longitude 721,1, on the line of numbers.

BY INSPECTION.

As in Case V. Plane Sailing. find the course by seeking in Table II. till against the distance, in its column, is found the given departure in one of the following columns, adjoining to which in the other column will be the difference of latitude, which if greater than the departure the course will be at the top, but if less the course will be found at the bottom. Then take the middle latitude as a course, and find the departure in the column of difference of latitude, against which, in the distance column, will be found the difference of longitude.

Thus, one-third of the distance, 215, and one-third of the departure, 166,7, are found nearly to correspond to a course of 51 degrees, and a difference of latitude of 135,8, which multiplied by 3 gives the sought difference of latitude 406 nearly; then with the middle latitude, 46°, as a course, I enter the Table, and seek for one-fifth of the departure=100, in the latitude column, the distance corresponding, 144, being multiplied by 5 gives the difference of longitude 720 nearly.

QUESTIONS FOR EXERCISE.

Question I. Required the bearing and distance between two places, one in the latitude of 37° 55′ N. and longitude of 54° 23′ W. the other in the latitude of 32° 38′ N. and longitude of 17° 5′ W.?

Answer. S. 80° 9′ E. and N. 80° 9′ W. distance 1854 miles.

Question II. Required the direct course and distance, from a place in the latitude of 36° 55′ S. and longitude of 20° 0′ E. to another place in the latitude of 32° 38′ S. and longitude of 8° 54′ W.?

Answer. N. 79° 46′ W. distance 1447 miles.

Question III. A ship from the latitude of 37° 30′ S. and longitude of 60° E. sails N. 79° 56′ W. 202 miles; required the latitude and longitude in?

Answer. Latitude 36° 55′ S. longitude 55° 50′ E.

Question IV. A ship from the latitude of 34° 35′ N. and longitude of 45° 16′ W. sails S. 83° 36′ E. 101 miles; required her latitude and longitude?

Answer. Latitude 34° 24′ N. longitude 43° 14′ W.

MERCATOR'S SAILING.

THE calculations by Middle Latitude Sailing are sufficiently exact for a short run, or a day's work, and are to be preferred in all cases where the difference of latitude is small in comparison of the difference of longitude; but this method is liable to great errors in calculating the situations of places differing greatly in latitude and longitude, particularly in high latitudes; to remedy this inconvenience, a chart was invented and published in the year 1566, by GERARD MERCATOR, a Flemish Geographer, in which all the meridians are parallel to each other, but proportionally lengthened so as to conform to the spherical figure of the earth. The principles on which this chart is constructed were first explained in the year 1599, by Edward Wright, an Englishman, and are as follows.

By Theorem II. of Parallel Sailing, the distance of two meridians corresponding to a degree or mile of longitude, in any latitude, is to the length of a corresponding degree or mile of the meridian, as the co-sine of the latitude is to the radius, that is (*by Art.* LVI. *Geo.*) as radius is to the secant of the latitude. Hence, if the meridians are supposed to be parallel to each other, or the distance of the meridians to remain the same in every latitude, the degree or mile of latitude must be increased in proportion to the secant of the latitude. Therefore, if the radius be supposed to be equal to one mile, the length of the first mile of latitude from the equator will be represented by the secant of 1′, the second mile by the secant of 2′, the third mile by the secant of 3′, &c. Therefore the length of the expanded arch of the meridian may be found by a continual addition of secants, to every degree and minute of the quadrant, as in Table III. by means of which the chart (called Mercator's chart) may be constructed, and all the cases of Mercator's Sailing may be projected and calculated.*

In using this table, the degrees are to be found at the top or the bottom, and the miles at the side; in the angle of meeting will be the length of the corresponding expanded arch, usually called the *meridional parts.* If you wish to find the arch of the expanded meridian intercepted between any two parallels, or, as it is usually called, the *meridional difference of latitude,* you must, *when both places are on the same side of the equator, subtract the meridional parts of the lesser latitude from the meridional parts of the greater, the remainder will be the meridional difference of latitude: but if they are on different sides of the equator, the sum of the meridional parts of both latitudes will be the meridional difference of latitude required.*

EXAMPLE I.

Required the meridional parts corresponding to the latitude of 42° 34′?

Look in the bottom or top of the table for 42°, marked 42 d. and in the right or left hand column marked (M) for 34′, under the former and opposite the latter stand 2828, the meridional parts corresponding to 42° 34′.

EXAMPLE II. Required the Meridional difference of latitude between Cape Cod, in the lat. of 42° 5′ N. and the Island of St. Mary, in the latitude of 36° 59′ N.?

Cape Cod's lat. 42° 5′ N. Mer. parts	2788
St. Mary's lat. 36° 59′ N. Mer. parts	2391
Meridional difference of latitude	397

EXAMPLE III. Required the meridional difference of latitude between a place in the lat. of 35° 12′ N. and the Cape of Good Hope, in the latitude of 34° 26′ S.?

Lat. 35° 12′ N. Mer. par.	2259
C. of G. Hope's lat. 34° 26′ S. Mer. par.	2203
Sum is meridional difference of lat.	4462

From these principles it follows, that in sailing upon any course, *the true or proper difference of latitude is to the departure as the meridional difference of latitude is to the difference of longitude.* Hence if MI (in the figure of Case I. following) be the proper difference of latitude, IO the departure,

* The manner of constructing this chart will be particularly explained hereafter. It may be observed, that the smaller the subdivisions of the arch of the meridian are, the greater will be the accuracy of the calculated length of the expanded arch of the meridian. To be perfectly accurate the arch ought to be subdivided into the smallest quantities possible. Attention was paid to this circumstance in calculating the above-mentioned Table.

MO the distance, the angle IMO the course, and we take MT equal to the meridional difference of latitude, and draw TH parallel to IO to cut MO continued in H; the line TH will represent the difference of longitude: for *(by Art.* LIII. *Geom.)* MI : IO : : MT : TH. Now in the triangle MTH, by making MT radius, we have MT : radius : : TH : tang. TMH, that is *the meridional difference of latitude is to radius, as the difference of longitude is to the tangent of the course.* By making MH or TH radius we shall have other analogies, which combined with those in Plane Sailing, furnish the solutions of the various cases of Mercator's Sailing contained in the following table.

MERCATOR'S SAILING.

Case.	Given.	Sought.	SOLUTIONS.
1	Both Latitudes and Longitudes.	Course. Distance. Departure	Having both lats. the mer. diff. lat. is found by Table III. Mer. Diff. Lat. : Rad : : Diff. Long. : Tang. Course. { Rad. : Prop. Diff. Lat. : : Secant Course : Distance. { Co-Sine Course : Prop. Diff. Lat. : : Rad. : Distance. { Rad. : Prop. Diff. Lat. : : Tang. Course : Departure. { Mer. Diff. Lat. : Diff. Long. : : Prop. Diff. Lat. : Depart.
2	Both Latitudes and Departure.	Course. Distance. Diff. Long	Merid. Diff. Lat. being found by Table III. we have Prop. Diff. Lat. : : Radius : : Departure : Tang. Course. { Radius : Prop. Diff. Lat. : : Sec. Course : Distance. { Sine Course : Departure : : Radius : Distance. { Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. : : Mer. Diff. Lat. : Diff. Long.
3	One Latitude, Course and Distance.	Departure. Diff. Lat. Diff. Long.	Radius : Distance : : Sine Course : Departure. Rad. : Dist. : : Co-sine Course : Prop. Diff. Lat. Hence we have the other latitude and mer. diff. lat. by Table III. Rad : Mer. Diff. Lat. : : Tang. Course : Diff. Long.
4	Both Latitudes and Course.	Distance. Departure. Diff. Long.	Co-sine Course : Prop. Diff. Lat. : : Rad. : Dist. Rad. : Prop. Diff. Lat. : : Tang. Course : Departure. Mer. diff. lat. being found in Table III. we have Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long.
5	Both Latitudes and Distance.	Course. Departure. Diff. Long.	Dist. : Rad. : : Prop. Diff. Lat. : Co-sine Course. Radius : Distance : : Sine-Course : Departure. Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long.
6	One Latitude, Course and Departure.	Diff. Lat. Distance. Diff. Long.	Rad. : Dep. : : Co-tang. Course : Prop. Diff. Lat. Hence we have the other latitude and mer. diff. latitude. Sine Course : Departure : : Radius : Distance. { Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. : : Mer. Diff. Lat. : Diff. Long.
7	One Latitude, Distance and Departure.	Course. Diff. Lat. Diff. Long.	Dist. : Rad. : : Dep. : Sine Course. Rad. : Dist. : : Co-sine Course : Diff. Lat. Hence we obtain the other latitude and meridian difference latitude. { Rad. : Mer. Diff. Lat. : : Tang. Course : Diff. Long. { Prop. Diff. Lat. : Dep. : : Mer. Diff. Lat. : Diff. Long.

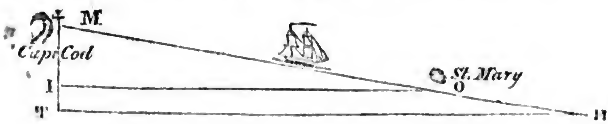
CASE I.

The latitudes and longitudes of two places given, to find the direct course and distance between them.

Required the bearing and distance from Cape Cod Light House in the latitude of 42° 5′ N. and longitude 70° 4′ W. to the island of St. Mary, one of the Western Islands, in the latitude of 36° 59′ N. and longitude of 25° 10′ W. ?

Cape Cod's lat.	42° 5′ N.	Meridional parts	2788	Long. 70° 4′ W.
St. Mary's lat.	36 59 N.	Meridional parts	2391	25 10 W.
	5 6	Mer. diff. lat.	397	44 54
	60			60
Difference of lat.	306 miles.		Diff. of long.	2694 miles.

BY PROJECTION.



Draw the meridian MT equal to the meridional difference of latitude 397 miles, set off also upon it MI equal to the proper difference of latitude 306 miles; perpendicular to MT draw TH and IO, make TH equal to the difference of longitude 2694 miles, draw MH cutting IO in O; then will the angle TMH be the course S. 81° 37′ E. and OM the distance 2099 miles.

BY LOGARITHMS.

To find the course.		To find the distance.	
As the mer. diff. of lat. 397	2.59879	As radius 90°	10.00000
Is to radius 45°	10.00000	Is to the proper diff. of lat. 306	2.48572
So is the diff. of long. 2694	3.43040	So is secant of course 81° 37′	10.83626
To tang. of course 81° 37′	10.83161	To the distance 2099 miles	3.32198

BY GUNTER.

1st. Extend from the meridional difference of latitude 397 to the difference of longitude 2694 on the line of numbers; that extent will reach from the radius or 45°, to the course 81° 37′ on the line of tangents.

2dly. Extend from the complement of the course 8° 23′ to radius 90° on the line of sines, that extent will reach from the proper difference of latitude 306, to the distance 2099 on the line of numbers.

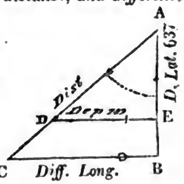
BY INSPECTION.

With the meridional difference of latitude and difference of longitude used as difference of latitude and departure, find the course, by inspecting the tables until those numbers are found to correspond; with this course and the proper difference of latitude, find the corresponding distance.

Thus one tenth of the merid. diff. lat. and diff. long. are found to agree nearly to a course of 7¼ points; this course and one tenth of the proper difference of latitude 30,6 is found to correspond to the distance 209; this multiplied by 10 gives the distance 2090, differing a little from the result by lagarithms, owing to the neglect of a few minutes in the course.

CASE II.

Both latitudes and the departure given, to find the course, distance, and difference of longitude.



A ship in the latitude of 49° 57′ N. and longitude of 15° 16′ W. sails south-westerly until her departure is 789 miles, and then by observation is in the latitude of 39°20′ N. required her course, distance and longitude in?

Lat. left	49° 57′ N.	Mer. parts	3470
Lat. in	39 20 N.	Mer. parts	2571
Diff. lat.	10 37=637 m.	Mer. diff. lat.	899

BY PROJECTION.

With the proper difference of latitude and departure, project as in Case VI. Plane Sailing, by drawing the meridian AEB, on which take AE equal to the proper difference of latitude 637 miles; erect ED perpendicular to AE and make it equal to the departure 789 miles; join AD and continue it towards C: make AB equal to the meridional difference of latitude 899 miles, and draw BC perpendicular to AB, to cut AC in C, and it is done. For AD will be the distance 1014 miles, BC the difference of longitude 1114 miles, and the angle BAC will be the course S. 51° 5′ W.

BY LOGARITHMS.

To find the course.		To find the distance.	
As the proper diff. of lat. 637	2.80414	As radius	10.00000
Is to radius 45°	10.00000	Is to prop. diff. of lat. 637	2.80414
So is the departure 789	2.89708	So is sec. course 51° 5′	10.20191
To tang. course 51° 5′	10.09294	To the distance 1014	3.00605
To find the diff. of long.		Longitude left	15° 16′ W.
As radius 45°	10.00000	Diff. of long. 1114 =	18 34 W.
Is to mer. diff. of lat. 899	2.95376	Longitude in	33 50 W.
So is tang. course 51° 5′	10.09294		
To diff. of long. 1114	3.04670		

The diff. of long. may also be found by saying, as prop. diff. of lat. : dep. :: mer. diff. lat. : diff. of long.

BY GUNTER.

1st. The extent from the diff. of lat. 637 to the dep. 789 on the line of numbers, will reach from radius 45° to the course 51° 5′ on the line of tangents.

2dly. The extent from the course 51° 5′ to radius 90° on the sines, will reach from the departure 789 to the distance 1014 on the line of numbers.

3dly. The extent from the radius 45° to the course 51° 5′ on the line of tangents, will reach from the merid. diff. of lat. 899 to the difference of longitude 1114 on the line of numbers.

BY INSPECTION.

Find the course by Plane Sailing, Case VI. by seeking in the tables with the proper difference of latitude and departure till they are found to agree in their respective columns, corresponding to which will be the distance in its column, and the course will be found at the top of that column if the departure is less than the proper difference of latitude, otherwise at the bottom; with the same course, find the meridional difference of latitude in the latitude column, corresponding to which in the departure column will be the true difference of longitude.

Thus with one tenth of the true difference of latitude and departure 63,7 and 78,9, I find the course 51°, and the distance 101, which multiplied by 10 gives nearly the true distance 1010; in the same table, opposite to one tenth of the meridional difference of latitude 89,9 I find the departure 111,1, which multiplied by 10 gives the difference of longitude 1111 miles.

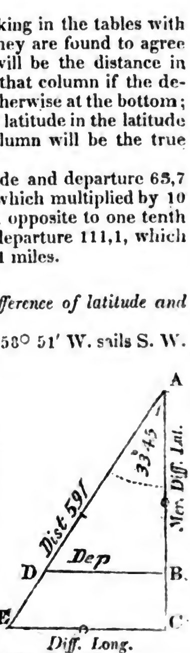
CASE III.

One latitude, course and distance given, to find the difference of latitude and difference of longitude.

A ship in the latitude of 42° 30′ N. and longitude of 58° 51′ W. sails S. W. by S. 591 miles; required the latitude and longitude in?

BY PROJECTION.

Draw the meridian ABC, and ADE, making an angle with it equal to the course 3 points, make AD equal to the distance sailed, 591 miles, and from D let fall upon AB the perpendicular BD: then will BD be the departure, and AB the difference of latitude, 491 miles. Hence we have both latitudes, and the meridional difference of latitude, to which make AC equal, and draw CE parallel to BD meeting ADE in E, then will CE be the difference of longitude, 419,6 miles.



BY LOGARITHMS.

To find the diff. of latitude.		To find the diff. of longitude.	
As radius 8 points	10.00000	As radius 4 points	10.00000
Is to the distance 591	2.77159	Is to the mer. diff. of lat. 628	2.79796
So is co-sine course 3 points	9.91985	So is tang. course 3 points	9.82489
To prop. diff. lat. 491.4	2.69144	To diff. of long. 419.6	2.62285
Lat. left 42° 30′ N. Mer. parts	2822	Long. left 58° 51′ W.	
Diff. Lat. 491=8 11 S.		Diff. of long. 420= 7 00 W.	
Lat. in 34 19 N. Mer. parts	2194	Long. in 65 51 W.	
Mer. diff. lat.	628		

BY GUNTER.

1st. The extent from radius 8 points to the complement of the course 5 points, on the line marked SR, will reach from the distance 591 to the difference of latitude 491.4 on the line of numbers.

2dly. The extent from the radius 4 points to the course 3 points, on the line marked TR, will reach from the meridional difference of latitude 628 to the difference of longitude 419.6 on the line of numbers.

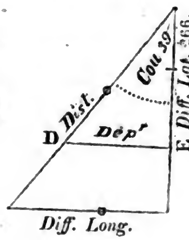
BY INSPECTION.

As in Case I. Plane Sailing, find the course at the top or bottom of the tables, either among the points or degrees, and in that page, opposite the distance, will be found the difference of latitude and departure in their respective columns. Then in the same table find the meridional difference of latitude in the latitude column; corresponding to which, in the departure column, will be the difference of longitude.

Thus, under the course S. W. by S. or 3 points, and opposite one third of the distance 197, stands 163,8 in the latitude column, which multiplied by 3 gives the difference of latitude 491,4 miles; then find one fourth of the meridional difference of latitude 157 in the latitude column, against which stands 105 in the departure column, which multiplied by 4 gives 420 the difference of longitude.

CASE IV.

Both latitudes and course given, to find the distance and difference of longitude.



A ship from the latitude of 49° 57′ N. and longitude of 30° W. sails S. 39° W. till she arrives in the latitude of 45° 31′ N. Required the distance run and longitude in?

Lat. left	49° 57′ N.		Mer. parts	3470
Lat. in	45 31 N.		Mer. parts	3074
Diff. lat.	4 26=266 m.		Mer. diff. lat.	396 miles.

BY PROJECTION.

Draw the meridian AEB, on which take AE equal to the proper difference of latitude 266 miles, and AB equal to the meridional difference of latitude 396 miles; make the angle BAC equal to the course 39°, and draw ED, BC, perpendicular to AB, cutting ADC in D and C; then will AD be the distance 342 miles, and BC the difference of longitude 321 miles.

BY LOGARITHMS.

To find the distance.		To find the diff. of longitude.	
As the co-sine course 39°	9.89050	As radius 45°	10.00000
Is to the prop. diff. of lat. 266	2.42488	Is to mer. diff. of lat. 396	2.59770
So is radius 90°	10.00000	So is tang. course 39°	9.90837
To the distance 342.3	2.53438	To the diff. of long. 320.7	2.50607

Longitude left		30° 0′ W.
Diff. of long.	321 =	5 21 W.
Longitude in		35 21 W.

BY GUNTER.

1st. The extent from the complement of the course 51° to the radius 90° on the sines, will reach from the proper difference of latitude 266, to the distance 342,3 on the line of numbers.

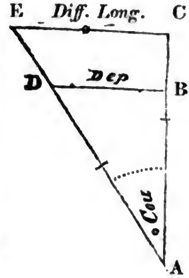
2dly. The extent from radius 45° to the course 39° on the line of tangents, will reach from the meridional difference of latitude 396, to the difference of longitude 321 on the line of numbers.

BY INSPECTION.

As in case II. Plane Sailing, find the course among the points or degrees and the proper difference of latitude in its column, adjoining to which will be the distance and departure in their respective columns; then in the same table, find the merid. diff. of lat. in the lat. column, adjoining to which in the departure column, will be the difference of longitude.

Thus, under the course 39° and opposite the half diff. of lat. 133 (the

nearest to which is 132.9) stand 171 and 107,6, these doubled give the distance 342 and departure 215.2; and in the same table opposite the half mer. diff. of lat. 198 found in the latitude column, stands 160.5 in the dep. column, which doubled gives the difference of longitude 321 miles, nearly as before.



CASE V.

Both latitudes and distance given, to find the course, and difference of longitude.

A ship from the latitude of 37° N. and longitude of 32° 16′ W. sails 300 miles north-westerly, until she is in the latitude of 41° N. Required the course steered and longitude in?

Lat. left	37° N.	Mer. parts	2393
Lat. in	41° N.	Mer. parts	2702
Diff. lat.	4°=240 miles.	Mer. diff. lat.	309 miles.

BY PROJECTION.

Draw the meridian ABC; make AB equal to the proper difference of latitude 240, and AC equal to the meridional difference of latitude 309 miles, draw BD and CE perpendicular to ABC; with an extent equal to the distance 300 in your compasses, and one foot in A as a centre, describe an arch cutting BD in D; draw AD, which continue to cut CE in E, and it is done; for the angle BAD is equal to the course of 36° 52′, BD is the departure, and CE is the difference of longitude 231.7 miles.

BY LOGARITHMS.

To find the course.		To find the diff. of longitude.	
As the distance 300	2.47712	As radius 45°	10.00000
Is to radius 90°	10.00000	Is to the mer. diff. of lat. 309	2.48996
So is prop. diff. of lat. 240	2.38021	So is tang. course 36° 52′	9.87501
To cosine course 36° 52′	9.90309	To the diff. long. 231.7	2.36497

Longitude left	32° 16′ W.
Diff. of longitude 232 =	3 52 W.
Longitude in	36 08 W.

BY GUNTER.

1st. The extent from the distance 300 to the proper difference of latitude 240, on the line of numbers, will reach from the radius or 90° to 53° 8′ the complement of the course on the line of sines.

2dly. The extent from radius 45° to the course 36° 52′ on the line of tangents, will reach from the meridional difference of latitude 309 to the difference of longitude 231.7, on the line of numbers.

BY INSPECTION.

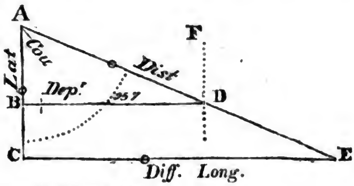
As in Case IV. Plane Sailing, seek in the table till against the distance taken in its column is found the given difference of latitude in one of the following columns; adjoining to it will stand the departure, which if less than the difference of latitude, the course will be found at the top, otherwise at the bottom; in the same table find the meridional difference of latitude in the latitude column, adjoining to which in the departure column will stand the difference of longitude.

Thus the distance 300 and the difference of latitude 240, are found to correspond to a course of 37°, and a departure of 180.5; and in the latitude column, opposite half the meridional difference of latitude 154.5 (the nearest to which is 154.1) stands 116.2 in the departure column, which doubled gives the difference of longitude 232.4.

CASE VI.

One latitude, course and departure given, to find the distance, difference of latitude, and difference of longitude.

A ship from the latitude of 50° 10′ S. and longitude of 30° E. sails E. S. E. until her departure is 957 miles; required the distance sailed, and the latitude and longitude in?



BY PROJECTION.

Draw the meridian ABC, and at a distance from it equal to the departure 957 miles, draw the line FD parallel to ABC; make the angle BAD equal to the course 6 points, draw AD to cut FD in D; from D let fall upon AB the perpendicular DB; then will AD be the distance 1036 miles, AB the difference of latitude 396 miles; hence we have both latitudes, and the meridional difference of latitude 667 miles, make the line AC equal thereto, and draw CE perpendicular to AC meeting AD continued in E; then will CE be the difference of longitude 1610 miles.

BY LOGARITHMS.

To find the distance.	
As the sine course 6 points	9.96562
Is to the departure 957	2.98091
So is radius 8 points	10.00000
To the distance 1036	3.01529
To find the diff. of lat.	
As radius 4 points	10.00000
Is to the departure 957	2.98091
So is co-tang course 6 points	9.61722
To prop. diff. of lat. 396.4 miles	2.59813

Lat. left	50° 10′ S.	Mer. parts	3490
Diff. lat. 396′=6	36 S.		
Lat. in	56 46 S.	Mer. parts	4157
	Merid. diff. of lat.		667
As radius 4 points			10.00000
Is to the merid. diff. of lat. 667			2.82418
So is tang. course 6 points			10.38278
To diff. long. 1610′=26° 50′ E.			3.20691
Long. left	30 00 E.		
Long. in	56 50 E.		

BY GUNTER.

1st. The extent from the course 6 points to radius 8 points on the line marked S. R. will reach from the departure 957 to the distance 1036 on the line of numbers.

2dly. The extent from radius 4 points to the complement of the course 2 points, on the line marked T. R. will reach from the departure 957 to the difference of latitude 396 on the line of numbers.

3dly. The same extent (from the radius 4 points to the course 6 points on the line marked T. R.) will reach from the meridional difference of latitude 667, to the difference of longitude 1610, on the line of numbers.

BY INSPECTION.

As in Case III. Plane Sailing, find the course either in Table I. or Table II. and the departure in its column, corresponding to which will stand the distance and difference of latitude in their respective columns: in the same Table find the meridional difference of latitude, in the latitude column, corresponding to which, in the departure column, will be found the difference of longitude.

Thus, over the course E. S. E. or 6 points, and against one-fifth of the departure 191.4 stand 79.2 and 207, which multiplied by 5 give the difference of latitude 396 miles, and the distance 1035 miles; then in the latitude column find a tenth of the meridional difference of latitude 66.7, the nearest to that is 66.6, against which, in the departure column, stands 160.8, which multiplied by 10 gives 1608, the difference of longitude.

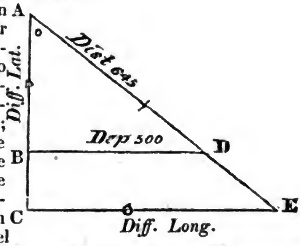
CASE VII.

One latitude, distance sailed, and departure given, to find the course, difference of latitude, and difference of longitude.

A ship in the latitude of 49° 30′ N. and the longitude of 25° W. sails south-easterly 645 miles, making 500 miles departure; required the course steered, and the latitude and longitude in?

BY PROJECTION.

Draw the meridian ABC, and on any point of it draw BD perpendicular thereto, and make it equal to the departure 500 miles; with an extent equal to the distance 645 miles in your compasses, and one foot on D as a centre describe an arch to cut AB in A, join AD; then will AB be the proper difference of latitude 407.5 miles, and the angle BAD will be the course 50° 49′; hence we have the other latitude, and the meridional difference of latitude, to which make AC equal; and draw CE parallel to BD, meeting AD produced in E; then will CE be the difference of longitude, 722.6 miles.



BY LOGARITHMS.

To find the course.	
As the distance 645	2.80956
Is to radius 90°	10.00000
So is the departure 500	2.69897
To sine of course 50° 49′	9.88941
To find the diff. of long.	
As radius 45°	10.00000
Is to mer. diff. of lat. 589	2.77012
So is tang. course 50° 49′	10.08879
To diff. of long. 722.6	2.85891
Or thus:	
As prop. diff. of lat. 407.5*	2.61014
Is to the departure 500	2.69897
So is the mer. diff. of lat. 589	2.77012
	5.46909
	2.61014
To diff. of long. 722.7	2.85895

To find the diff. of lat.				
As radius 90°				10.00000
Is to the distance 645				2.80956
So is co-sine course 50° 49′				9.80058
To diff. l. 407.5=6° 48′ S.				2.61014
Lat. left	49	30	N. M. par.	3428
Lat. in	42	42	N. M. par.	2839
Mer. diff. lat.				589
Long. left	25	00	W.	
Diff. long.	12	3	E.	
Long. in	12	57	W.	

Hence the ship's course is S. 50° 49′ E. Lat. in 42° 42′ N. Long. in 12° 57′ W.

BY GUNTER.

1st. The extent from the distance 645 to the departure 500 on the line of numbers, will reach from the radius 90° to the course 50° 49′ on the line of sines.

2dly. The extent from radius 90° to the complement of the course 39° 11′ on the line of sines, will reach from the distance 645 to the difference of latitude 407.5 on the line of numbers.

3dly. The extent from the radius 45° to the course 50° 49′ on the line of tangents, will reach from the mer. diff. of lat. 589 to the difference of longitude 722.6 on the line of numbers. Or, the extent from the proper difference of latitude 407.5 to the departure 500, will reach from the meridional difference of latitude 589 to the difference of longitude 722.7 on the line of numbers.

BY INSPECTION.

Find the course and difference of latitude, as in Case V. Plane Sailing, by seeking in Tab. II. till the distance and departure are found to correspond in their respective columns, adjoining to which, in the column of latitude, will

* This log. was found above—it differs a little from the log. of 407.5.

be found the true difference of latitude, which if greater than the departure the course will be found at the top; but if less, the course will be found at the bottom: with this course seek the meridional difference of latitude in the latitude column, adjoining to which in the departure column will be found the difference of longitude.

Thus one-third of the distance 215, and one-third of the departure 166,7 are found nearly to correspond to a course of 51 degrees, and a difference of latitude of 135.3, which multiplied by 3, gives the true difference of latitude 406 nearly. Then one-fourth of the meridional difference of latitude 147, in the latitude column, is found nearly to correspond to the departure 181.9; this multiplied by 4, gives 727.6 the difference of longitude nearly.

Having explained the method of calculating single courses by Middle Latitude and Mercator's Sailing, it now remains to explain the method of calculating compound courses. To do this, you must construct a Traverse Table, and find the difference of latitude and departure for each course and distance, as in Traverse Sailing, and from thence the whole difference of latitude, departure, and latitude in, with the departure and latitudes, find the difference of longitude and longitude in, as in Case II. of Middle Latitude or Mercator's Sailing.

This method is exact enough for working any single day's work at sea, except in high latitudes, where it will be a little erroneous; in this case the difference of longitude and longitude in, may be calculated for every single course and short distance; but in general this nicety in calculation may be neglected.

To illustrate the method of working compound courses, we shall here work an example, by Middle Latitude and Mercator's Sailing.

EXAMPLE.

A ship from Cape Henlopen, in the latitude of 38° 47′ N. longitude 75° 17′ W. sails the following true courses, viz. E. by S. 20 miles, E. N. E. 15 miles, S. E. 26 miles, South 16 miles, W. S. W. 6 miles, N. W. 10 miles, and East 30 miles: required her latitude and longitude?

By constructing the Traverse Table with these courses and distances, it appears that the ship has made 27.8 miles of southing, and 69.3 miles of easting; and by subtracting the southing from the latitude of Cape Henlopen there remains the latitude in 38° 19′ N.

TRAVERSE TABLE.

Courses.	Dis.	Diff. Lat. N.	Diff. Lat. S.	Departure. E.	Departure. W.
E. by S.	20		3.9	19.6	
E. N. E.	15	5.7		13.9	
S. E.	26		18.4	18.4	
South.	16		16.0		
W. S. W.	6		2.3		5.5
N. W.	10	7.1			7.1
East.	30			30.0	
		12.8	40.6	81.9	12.6
			12.8	12.6	
		D.Lat.	27.8	69.3	Dep.

Cape Henlopen's latitude	38° 47′ N.	Meridional parts	2528
Latitude in	38 19 N.	Meridional parts	2492
Sum of latitudes	77 6		36
Middle latitude	38 33		

By inspection of Table II. it appears that the difference of latitude 27.8 and departure 69.3 correspond to a course of 68° nearly, and a distance of 75 miles; and in the same page of the Table opposite to the meridional difference of latitude, found in the column of latitude, stands the difference of longitude 89 miles in the departure column; this subtracted from the longitude of Cape Henlopen 75° 17′ W. leaves the longitude in 73° 38′ W. by Mercator's Sailing. Or, with the Middle Latitude 38° 33′ to 39° as a course, find the departure 69.3 in the latitude column, opposite to which is 89 in the distance column, which is the difference of longitude by Middle Latitude Sailing; consequently the longitude in is 73° 38′ W. as above.

Thus we see that such examples are performed as in Traverse Sailing and Case II. of Mercator's or Middle Latitude Sailing, either by Inspection, as above, or by the scale of logarithms.

Having gone through the necessary problems in Mercator's Sailing, we shall now show how Mercator's Chart may be constructed by means of the Table of Meridional Parts.

To construct a Mercator's Chart to commence at the Equator.

Suppose it was required to construct the Chart in the Plate prefixed to this work which begins at the equator, and reaches to the parallel of 50 degrees, and contains 95 degrees of longitude west from the meridian of Greenwich?

Draw the line AD representing the equator, then take from any scale of equal parts the number of minutes contained in 95 degrees, viz. 5700, which set off from A to D; subdivide this line into 95 equal parts representing degrees of longitude. Through A and D draw the lines AB, DC perpendicular to AD, and make each of them equal to 3474 which are the meridional parts, corresponding to 50 degrees. Join BC which must be subdivided in the same manner as the line AD; and through the corresponding points of the lines AD, BC must be drawn (at the distance of 10° or 20°) the lines parallel to AB, representing meridians of the earth; these lines must be numbered 0, 10, 20, &c. beginning at the line AB which represents the meridian of Greenwich. Set off in like manner upon the meridians AB, DC, (beginning from the equator AD) the meridional parts corresponding to each degree of latitude from 0° to 50°; and through the corresponding points (at the distance of 10° or 20°) draw lines parallel to the equator AD, to represent the parallels of latitude. Then the upper part of the chart will represent the north, the lower the south, the right hand the east, and the left hand the west (which is generally supposed in charts, unless the contrary is expressly mentioned.)

If the Chart does not commence at the equator, but is to serve for a certain portion of the globe contained between two parallels of latitude on the same side of the equator, you must draw the meridians as directed in the last example; then subtract the meridional parts of the least latitude of the chart from the meridional parts of the other latitudes, and set off these differences on the extreme meridians, draw lines through the corresponding points, and they will be the parallels of latitude on the chart.

If the chart is to be bounded by parallels of latitude on different sides of the equator, you must draw a line representing the equator, and perpendicular to it draw the lines to represent the meridians, continuing them on both sides of the equator; then set off the parallels of latitude on both sides of the equator, in the same manner as in the first example.

Take from the Table of latitudes and longitudes of places the latitude and longitude of each particular place contained within the bounds of the chart, and lay a rule over its latitude and another crossing that over its longitude; the point where these meet will represent the proposed place upon the chart. The most remarkable point of a sea coast being thus laid down, lines may be drawn from point to point which will form the outlines of the sea coast, islands, &c. to which may be annexed the depths of water expressed in common Arabian numbers, the time of high water on the full and change days expressed in Roman numbers: the setting of the tide expressed by an arrow; and whatever else may be thought convenient for the chart to contain.

This chart is not to be considered as a just representation of the earth's surface, for the figures of islands and countries are distorted towards the poles, as is evident from the construction; but the degrees of latitude and longitude are increased in the same proportion, so that the bearings between places will be the same on the chart as on the globe; and as the meridians are right lines, it follows, that the rhumbs, which form equal angles with the meridians, will be straight lines, which render this projection of the earth's surface much more easy and proper for the mariner's use than any other.

Having the latitude and longitude of a ship or place, to find the corresponding point on the chart.

Rule. Lay a ruler across the chart in the given parallel of latitude: take

in your compasses the nearest distance between the given longitude and the nearest meridian drawn across the chart; put one foot of the compasses in the point of intersection of the ruler and meridian, and extend the other along the edge of the ruler on the same side of the meridian as the place lies, and that point will represent the place of the ship.

If the longitude on the chart be counted from a different meridian from that you reckon from, you must reduce the given longitude to the longitude of the chart, by adding or subtracting the difference of longitude of those meridians, and then mark off the ship's place as before directed. Or, you may draw a meridian line through the place you reckon your longitude from; then measure off the ship's longitude on the equator, and apply it to the edge of the ruler, from this meridian, and you will obtain the ship's place.

To find the bearing of any place from the ship.

RULE. Lay a ruler across the given place and the place of the ship; set one foot of the compasses in the centre of some compass near the ruler, and take the nearest distance to the edge of the ruler; slide one foot of the compasses along that edge keeping the other extended to the greatest distance from the ruler, and observe what point of the compass it comes nearest to, for that will be the bearing required.

To find the distance of any place from the ship.

RULE. Take the distance between the ship and given place in your compasses and apply it to the side of the chart or graduated meridian, setting one foot as much above one place as the other is below the other place, the number of degrees between the points of the compasses will be the distance nearly.

When the places bear north and south of each other this rule is accurate; but when they bear nearly east and west, and the distance is large, it will err considerably; but in general it is exact enough for common purposes; if greater accuracy is required, it is best to find the distance by calculation.

If any one wishes to estimate the distance accurately by the chart, he must proceed in the following manner:

1. If the place be in the same longitude that the ship is in, then the preceding rule is accurate.
2. If the place be in the same latitude as the ship, or bear east or west, the distance cannot be obtained without calculating it by Case I. of Parallel Sailing.
3. If the place be neither in the same latitude, nor in the same longitude as the ship, the distance must be found in the following manner: Lay a ruler over both places, and draw through one of them a parallel to the equator: take the difference of latitude between both places in your compasses from the equator; slide one foot on that parallel, keeping the other extended so that both points shall be on the same meridian, and note the point of the ruler which is touched by the other foot of the compasses, take the distance from this point to the given place through which the parallel was drawn and apply it to the equator, and you will have the sought distance.

The bearing and distance of any two places from each other may be found in the same manner as the bearing and distance of any place from the ship.

EXAMPLE.

Required the bearing and distance between the east end of Long-Island and the north part of Bermudas?

A ruler being laid over both places as directed in the preceding rule, it will be found to lay parallel to the N. W. by N. and S. E. by S. line; and the distance between the two places being taken in the compasses, and applied to the graduated meridian, will measure about 10 degrees or 600 miles; therefore these places bear from each other N. W. by N. and S. E. by S. and their distance is 600 miles nearly.

OF THE LOG-LINE & HALF MINUTE GLASS.

VARIOUS methods have been proposed for measuring the rate at which a ship sails, but that most in use is by the Log and Half-Minute Glass.

The Log is a flat piece of thin board, of a sectoral or quadrantal form, (see Plate VI. Fig. 3) loaded on the circular side with lead sufficient to make it swim upright in the water: to this is fastened a line about 150 fathoms long, called the Log-line, which is divided into certain spaces called knots, and is wound on a reel (see Plate VI. Fig. 4) which turns very easily. The Half-Minute Glass is of the same form as an Hour Glass, (see Plate VI. Fig. 2) and contains such a quantity of sand as will run through the hole in its neck in half a minute of time.

The making of the experiment to find the velocity of the ship is called heaving the log, which is thus performed. One man holds the reel, and another the half-minute glass; an officer of the watch throws the log over the ship's stern, on the lee side, and when he observes the stray line is run off (which is about ten fathoms, this distance being usually allowed to carry the log out of the eddy of the ship's wake) and the first mark (which is generally a red rag) is going off, he cries *turn!* the glass holder answers *done!* who watching the glass, the moment it is run out says *stop!* the reel being immediately stopt, the last mark run off shows the number of knots, and the distance of that mark from the reel is estimated in fathoms. Then the knots and fathoms together, show the distance the ship has run the preceding hour, if the wind has been constant. But if the gale has not been the same during the whole hour, or time between heaving the log, or if there has been more sail set or handed, a proper allowance must be made. Sometimes when the ship is before the wind, and a great sea setting after her, it will bring home the log; in such cases it is customary to allow one mile in 10, and less in proportion if the sea be not so great; allowance ought also to be made if there be a head sea.

This practice of measuring a ship's rate of sailing is founded upon the following principle: That the length of each knot is the same part of a sea mile, as half a minute is of an hour. Therefore the length of a knot ought to be $\frac{1}{120}$ of a sea mile; but by various admeasurements it has been found that the length of a sea mile is about 6120 feet; hence the length of a sea knot should be 51 feet: each of these knots is divided into 10 fathoms of about 5 feet each. If the glass be only 28 seconds in running out, the length of the knot ought to be 47 feet and 6 tenths. These are the length generally recommended in books of navigation, but it may be observed, that in many trials it has been found, that a ship will generally over-run her reckoning with a log-line thus marked; and since it is best to err on the safe side, it has been generally recommended to shorten the above measures by 3 or 4 feet, making the length of a knot about 7½ fathoms of 6 feet each, to correspond with a glass that runs 28 seconds.

In heaving the log you must be careful to veer out the line as fast as the log will take it; for if the log is left to turn the reel itself, the log will come home and deceive you in your reckoning. You must also be careful to measure the log-line pretty often, lest it stretch and deceive you in the distance. Like regard must be had that the half-minute glass be just 30 seconds, otherwise no accurate account of the ship's way can be kept. The glass is much influenced by the weather, running slower in damp weather than in dry. The half-minute glass may be examined by a watch with a second hand, or by the following method—Fasten a plummet on a line and hang it on a nail, observing that the distance between the nail and middle of the plummet be 39⅛ inches, then swing the plummet and notice how often it swings while the glass is running out, and that will be the number of seconds measured by the glass.

To correct the distance when the log-line and half-minute glass are faulty.

If there be any error in the log-line or glass, the measured distance must

be corrected in the following manner, supposing that a 30″ glass requires 50 feet to a knot.

(1.) If the glass only is faulty, you must say, *as the seconds run by the glass are to 30 seconds, so is the distance given by the log to the true distance.* Thus if a ship sails 8½ knots per hour, by a glass of 33 seconds, the true number of knots per hour will be 7,1; for, 36 : 30 : : 8,5 : 7,1.

(2.) If the log-line only is faulty, you must say, *as 50 feet is to the distance of a knot on the line, so is the distance run by the log to the true distance.* Thus, if a ship sails 7 knots per hour, by a log-line measuring 53 feet, her true distance will be 7,4 miles per hour, because, 50 : 53 : : 7 : 7,4.

(3.) If the log-line and glass are both faulty, you must say, as 50* *multiplied by the length of the glass is to 30 multiplied by the length of the line, so is the measured to the true distance.* Thus, if a ship sails 6 knots per hour with a glass of 24 seconds, and a log-line of 60 feet per knot, her true velocity will be 9 miles per hour, because 50 × 24 : 30 × 60 : : 6 : 9.

DESCRIPTION AND USE

OF A

QUADRANT OF REFLECTION.

MR. JOHN HADLEY was the first who published a description of the *Quadrant of Reflection*, for measuring angular distances, and the instrument still bears his name, although it has been ascertained that Sir *Isaac Newton* invented a similar one some years before, but never made it public: one of our countrymen, Mr. *Thomas Godfrey*, of Philadelphia, had also contrived an instrument on the same principles some time before Mr. Hadley made known his discovery.

Figure 1, Plate VII. represents a Quadrant of Reflection, the principal parts of which are, the frame ABC, the graduated arch BC, the index D, the nonius or vernier scale E, the index glass F, the horizon glasses G and H, the dark glasses or screens I, and the sight vanes K and L.

The *graduated arch* BC is an octant or eighth part of a circle, but on account of the double reflection is divided into 90° numbered from 0° towards the left, and each degree is commonly divided into three equal parts of 20 minutes each. The graduation on the limb is continued a few degrees to the right of 0°; this portion is called the *arch of excess*, and is found very convenient for several purposes.

The *index* D is a flat bar commonly made of brass, moveable round the centre of the instrument, and broader towards the axis of motion, where is fixed the index glass F; at the other end is fixed the nonius or vernier scale, used in estimating the subdivisions of the arch; at the bottom or end of the index there is a piece of brass which leads under the arch, having a spring to make the vernier lie close to the limb, and a screw to fasten it in any position. Some quadrants have a tangent screw affixed to the lower part of the index to adjust its motion. The *vernier* is a small narrow slip of brass or ivory fixed to that part of the index which slides over the graduated arch, and usually contains a space equal to 21 or 19 divisions of the limb, and is divided into 20 equal parts; hence the difference between a division on the limb, and a division on the dividing scale, is one twentieth of a division of the limb, or one minute; therefore, if any division on the vernier is in the same straight line with a division of the limb, then no other division on the

* Instead of multiplying the length of the glass by 50, and the line by 30, you may multiply the former by 5, and the latter by 3. If any one chooses to mark the log line at less than 50 feet for a glass of 30 seconds, he must put his estimated length of the knot instead of 50, in all the above rules.

vernier can coincide with a division of the limb, the extreme divisions excepted. Some time ago it was usual to reckon the divisions on the vernier from its middle towards the right, and from the left towards the middle: but this being found inconvenient, a more commodious method has been introduced of numbering from right to left; hence the degree and minute, pointed out by the vernier, may be found thus: observe what minute on the vernier coincides with a division on the limb, then this minute, being added to the degree and parts of a degree on the limb immediately preceding the first division on the vernier, will be the degree and minute required. Thus, suppose 10′ on the vernier coincided with a division on the limb, and that the division on the limb preceding the first division of the vernier, was 8° 20′, the division pointed out by the vernier would be 8° 30′.

The *index glass* F, is a plane speculum or mirror of glass, quicksilvered and set in a brass frame; it is so placed that the face of it is perpendicular to the plane of the instrument, and is fixed to the index by the screw M; the other screw N serves to replace it in a perpendicular position, if by any accident it has been put out of order. The use of this mirror is to receive the rays from the sun, or other object observed, and reflect them towards the horizon glasses.

The *horizon glasses* G and H, are two small speculums—G is called the *fore horizon glass*, from its being used in the common or *fore observation*, where the observer's face is turned towards the object; and H the *back horizon glass*, being used in the *back observation*, where the observer's back is turned towards the object; these mirrors receive the reflected rays from the index glass and reflect them to the eye of the observer. The horizon glasses are not entirely quicksilvered; the fore-horizon glass G is only silvered on the lower half, the other part being transparent, and the back part of the frame cut away, that the horizon or any other object may be seen through it; the back-horizon glass H, is silvered at both ends; in the middle is a transparent slit, through which the horizon may be seen: these two glasses are set in brass frames similar to that of the index glass, and fixed on moveable bases, which are adjusted by screws so as to set the glasses in their true positions. In general there are three *dark glasses* or screens I, two red ones of different shades, and one green; each is set in a brass frame, which turns on a centre that they may be used separately or together: they serve to defend the eye from the rays of the sun during an observation. The green glass is peculiarly adapted to take off the glare of the moon, but may be used for the sun when much obscured by clouds. When these glasses are used for a fore-observation, they are to be fixed as in fig. I, but when used for a back-observation they are to be placed at O.

The *sight vanes*, K and L, are pieces of brass standing perpendicular to the plane of the instrument; the vane K is called the *fore-sight vane*, and L the *back-sight vane*. There are two holes in the fore-sight vane, the lower of which, and the upper edge of the silvered part of the fore-horizon glass are equi-distant from the plane of the instrument, and the other hole is opposite to the middle of the transparent part of that glass. The back-sight vane has one perforation which is exactly opposite to the middle of the transparent slit in the back-horizon glass.

The *adjusting-lever*, (fig. 2,) which is fixed on the back of the quadrant, serves to adjust the horizon glass, by placing it parallel to the index-glass; when this lever is to be made use of, the screw B must be first loosened, and when by the adjuster A the horizon glass is sufficiently moved, the screw B must be fastened again, by which means the horizon glass will be kept from changing its position.

To adjust a quadrant.

As the quadrant, from various accidents, is liable to be out of order, it is necessary that the mariner should be able to ascertain the errors, and re-adjust the several parts before he proceeds to make his observations. For this purpose he must examine whether the index glass and the horizon glasses be perpendicular to the plane of the instrument, and whether the plane of the fore-horizon glass be parallel, and that of the back-horizon glass

perpendicular to the plane of the index glass, when 0 on the vernier stands against 0 on the limb.

1st. *To ascertain whether the index glass be perpendicular to the plane of the Quadrant.*

Place the index on the middle of the arch, and hold the index glass near the eye, look into it, in a direction parallel to the plane of the instrument, and see if the reflected arch appear exactly in a line with the arch seen direct, or if the image of any point of the arch near B appear of the same height as the corresponding part of the arch near C seen direct, if so, the index glass is perpendicular to the plane of the quadrant; if not, the error must be rectified by the screws on the base behind the frame, by loosening the screw M, and tightening the screw N, or by loosening the screw N, and tightening the screw M.

2d. *To ascertain whether the fore-horizon glass be perpendicular to the plane of the Quadrant.*

Having adjusted the index glass, hold the instrument in a vertical position; look through the fore-sight vane, and move the index till the reflected and direct images of the horizon, seen in the horizon glass, coincide; then incline the instrument till its plane is nearly parallel to the horizon; if the images still coincide, the horizon glass stands perpendicular, otherwise it does not, and must be adjusted by the screws placed before and behind it, loosening one of them and tightening the other.

This adjustment may be made by the sun, moon, or star, by holding the quadrant in a vertical position, and observing if the object seen by reflection appears to the right or left of the object seen direct; and moving the screws as above till both images coincide.

After having made the horizon and index glasses parallel, according to the directions in the following article, it will be best to re-examine this adjustment.

3d. *To make the horizon glass parallel to the index glass when 0 on the vernier stands on 0 on the arch.*

Having fixed the index so that 0 on the vernier stands on 0 on the arch, look at any distant object and see if the image of it coincides with the object itself: if it does, the adjustment is complete; if not, they must be made to coincide by means of the adjusting lever. The horizon may be used for this purpose in the following manner: hold the plane of the instrument vertical, look through the lower hole in the vane K, and direct the sight through the transparent part of the Glass G to the horizon; then if the horizon line, seen in the silvered and transparent part, coincides, or makes one straight line, the horizon glass is said to be adjusted; but if the horizon lines do not coincide, slacken the screw B (fig. 2) in the middle of the adjusting lever, and turn the horizon glass on its axis until the horizon lines coincide, then fix the lever firmly by tightening the screw B. If this adjustment be again examined, it will perhaps be found imperfect; in this case, therefore, it remains either to repeat the adjustment, or find the error of it usually called the *index error*, which may be done thus—Let the horizon glass remain fixed, and move the index till the image and object coincide, then the difference between 0 on the vernier and 0 on the arch is the index error, which is to be added to the angle or altitude observed, if the 0 on the vernier be to the right hand of 0 on the arch, otherwise to be subtracted. Thus if the horizon was used, the instrument being held in a vertical position, you must look through the lower hole of the vane K, towards the horizon; then move the index till the reflected and direct images of the horizon coincide, the difference between 0 on the vernier and 0 on the arch will be the index error.

4th. *To adjust the back-horizon glass, that it may be perpendicular to the plane of the index glass, when 0 on the vernier stands on 0 on the arch.*

Set the index as far to the right of 0 on the arch as twice the dip of the horizon (taken from Table XIII.) hold the quadrant in a vertical position,

look towards the horizon through the hole in the back horizon vane L, and the transparent slit of the back horizon glass H, then if the reflected horizon, which will appear inverted, coincide with that seen direct, the glass is truly adjusted, otherwise the screw, in the centre of the lever on the under side of the quadrant, must be slackened, and the glass turned on its axis till both horizons coincide, when the lever should be fixed by tightening the screw.

5th. *To adjust the back horizon glass that it may be perpendicular to the plane of the quadrant.*

Put the index on 0; hold the quadrant nearly parallel to the horizon; look through the hole on the back sight vane, and if the true and reflected horizons appear in the same straight line, the glass is perpendicular to the plane of the instrument; but if they do not coincide, the sunk screws before and behind the glass must be turned till both appear to form one straight line.

To take an altitude of the Sun by a Fore Observation.

If the sun is bright, turn down one or more of the dark glasses; hold the instrument in a vertical position; apply the eye to the upper hole in the fore-sight vane, when the image is so bright as to be seen in the transparent part of the fore-horizon glass, otherwise to the lower hole; direct the sight to that part of the horizon beneath the sun, and move the index till you bring the image of his lower limb to touch the horizon directly under him; but as this point cannot be exactly ascertained, the observer should move his instrument round to the right and left a little, keeping as nearly as possible the sun always in that part of the horizon glass, which is at the same distance as the eye from the plane of the quadrant,* by which motion the sun will appear to sweep the horizon, and must be made to touch it at the lowest part of the arch; the degrees and minutes pointed out by the index will be the observed altitude of the sun's lower limb at that instant.

To take an altitude of the Moon by a Fore Observation.

In the night when the moon is bright, her image may be seen in the transparent part of the fore-horizon glass, and the observation may be taken exactly in the same manner as an observation of the sun. If the image is so faint as not to be seen in the transparent part of the horizon glass, you must set the index to 0, hold the plane of the quadrant in a vertical position, direct the sight to the moon, and at the same time look for her reflected image in the silvered part of the horizon glass; move the index forward till the moon's image, which will appear to descend, just touches the horizon, then sweep the quadrant as in observing the sun, and bring her round limb into contact with the horizon, whether it be her upper or lower. The degrees and minutes pointed out by the index will be the observed altitude of that limb which was brought in contact with the horizon.

To take an altitude of a Star by a Fore Observation.

This is done exactly in the same manner as in observing the moon's altitude when her image is so faint as not to be seen in the transparent part of the horizon glass.

To take the Sun's altitude by a Back Observation.

Put the dark glasses in the hole O, and turn one or more of them down, according to the brightness of the sun; then, holding the instrument in a vertical position, look through the back sight vane towards that part of the horizon opposite the sun; move the index till the sun's image is seen in the silvered part of the glass; give the quadrant a slow vibratory motion and the sun will appear to describe an arch with its convex side upward; bring the upper limb, when in the upper part of this arch, in contact with that part of the horizon seen through the transparent slit, and the degrees and minutes

* In common quadrants, if the upper hole be looked through, the sun's image must be made to appear in the middle of the transparent part of the horizon glass, but if the lower hole be looked through, the image must be made to appear on the line joining the silvered and transparent parts of the horizon glass, as these parts of the horizon glass are at the same distances from the plane of the instrument as the holes of the sight vanes respectively.

pointed out by the index, will be the altitude of the sun's lower limb. The altitude of the moon or a star, may be obtained in the same manner, only observing to bring the round edge of the moon to the horizon.

The back observation is but little used on account of the difficulty of adjusting and observing: various remedies have been proposed for these defects, but none have yet been generally adopted. The back observation of the altitude of any object is useful only when there is not an open horizon for the fore observation; but even in that case the fore observation might often be used, if the distance of the horizon was known, as will be explained farther on.

To take the meridian altitude of any celestial object by a Fore Observation.

When the object rises and sets, it comes to the meridian above the horizon only once in 24 hours, and is then at its greatest altitude, by observing which, the latitude may be easily determined. The sun comes to the meridian exactly at noon or 12 o'clock: the moon and stars at various hours. To observe the meridian altitude, begin a few minutes before the time of passing the meridian; bring the object to sweep the horizon according to the preceding directions; this must be repeated until the object begins to descend below the edge of the sea; the degrees and minutes then shewn by the index will be the meridian altitude.

If the object does not set, it comes to the meridian below the pole, and is then at its least altitude; this altitude may be observed as above directed with this difference, that you must continue sweeping till the object begins to rise above the edge of the sea, instead of descending below it.

The meridian altitude of any object may be taken in a similar manner by a back observation.

Strictly speaking, this method of finding the meridian altitude is absolutely accurate, only when the ship is at rest and the sun's declination constant. For if the ship is sailing towards the sun, the altitude will be increased, and it will be decreased if sailing from the sun; but the correction of altitude arising from this source is very small, and may be neglected in all nautical calculations, as will be shown hereafter.

Advice to Seamen in the choice of a Quadrant.

The joints of the frame must be close, without the least opening or looseness, and the ivory on the arch inlaid and fixed, so as not to rise in any place above the plane of the instrument; all the divisions of the arch and vernier must be exceedingly fine and straight, so that no two divisions of the vernier (except the first and last) coincide at the same time with the divisions of the arch. All the glasses belonging to the quadrant should have their surfaces perfectly plane, and their fore and back surfaces exactly parallel; the first of these requisites in the horizon glass and index glass may be thus verified by means of two distant objects: move the index till both objects are exactly in contact, at the upper edge of the silvered part of the horizon glass, then move the quadrant in its own plane so as to make the united images move along the line, separating the silvered from the transparent part of the horizon glass, and if in this motion the images continue united, the reflecting surfaces are good planes, otherwise the planes are imperfect. The parallelism of the two surfaces of the reflecting glasses may also be examined by viewing the image of some object reflected very obliquely, for if that image appears single and well defined about the edges, it is a proof that the surfaces are parallel; on the contrary, if the edge of the reflected image appears as if it threw a faint shadow from it, or separated like two edges, it is evident that the two surfaces of the glass are inclined to each other; if the image be the sun, and viewed through a small telescope, the examination will be more perfect. To examine the dark glasses, you must bring the image of a distant object to coincide with the object seen direct; then turn the coloured glass so that the plane which was next to the index glass may now be next to the horizon glass, and if the direct and reflected images still coincide, the surfaces of the glass are parallel.

DESCRIPTION AND USE

OF A

SEXTANT OF REFLECTION.

A SEXTANT is constructed on the same principles, and may be used for measuring altitudes, in the same manner, as a quadrant.* The arch of a sextant, as its name implies, contains 60°, but by reason of the double reflection, is divided into 120°. This instrument is particularly intended to measure the distance of the moon from the sun, or a fixed star, and as that distance is wanted as accurately as possible, to determine the longitude of the place of observation, the instrument is constructed with more care, and is provided with some additional appendages that are wanting in the quadrant. Fig. 3, Plate VII. represents a sextant, the frame of which is generally made of brass, or other hard metal, the handle at its back is made of wood; by this, when observing, the instrument is to be held with one hand, while the other is moving the index. The arch AA, is divided into 120°, each degree into three parts of 20 minutes each, and the vernier scale is in general so divided as to shew half minutes. In some sextants, the degree is divided into 6 equal parts of 10′ each, and the vernier shows 10″.

In order to observe with accuracy, and make the images come precisely in contact, a *tangent screw* B is fixed to the index, by which it may be moved with greater regularity than it can be by hand; but this screw does not act until the index is fixed by the screw C at the back of the sextant. Care should be taken not to force the tangent screw when it arrives at either extremity of its arch. When the index is to be moved any considerable quantity, the screw C must be loosened; but when the index is brought nearly to the division required, the back screw C should be tightened, and then the index moved gradually by the tangent screw.

In many sextants, the lower part of the index glass, or that next the plane of the instrument, is silvered as usual, and the back surface of the upper part painted black; a screen, painted black, is fixed by its axis to the base of the index glass, and may be placed over the silvered part when the rays are strong; in which case the image is to be reflected from the outer surface of the upper part, and the error which might probably arise from the planes of the glass not being parallel, is thereby avoided.

The coloured glasses are similar to those applied to a common quadrant, and are usually four in number, placed at D, to screen the eye from the solar rays and the glare of the moon; they may be used separately or together, as occasion requires. In addition to these, there are three similar glasses placed behind the horizon glass, to be used in finding the index error by means of the sun, and in observing the sun's altitude by an artificial horizon on land. The paler glass is sometimes used in observing altitudes at sea, to take off the strong glare of the horizon.

A sextant is generally furnished with a tube without glasses, and two tel-

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* There is not in general any apparatus for the back observation fixed to a sextant, but if the altitude of any celestial object be greater than 60°, the supplement of the altitude may be obtained by a back observation with a sextant with ease and accuracy, and as this method may be often used with advantage when a fore observation cannot be obtained, we shall here point out the method of taking the observation, and shall hereafter give the calculations for determining the latitude from a meridian observation, taken in this manner.—The back of the observer being turned to the sun, he must move the index till the image of the sun touches the edge of the back horizon, and then move the sextant a little to the right and left (as in a fore observation) and the image will describe an arch with the convex side upward; move the index till the lower limb of the image, when in the upper part of the arch, just touches the horizon, and the observation will be complete; observing that, if the telescope be used, the image must be brought in the middle between the two parallel wires; but if the telescope be not used, the image of the sun must be seen in the horizon glass at the same distance from the plane of the instrument as the eye of the observer. The altitude thus obtained will be the supplement of the altitude of the sun's upper limb. The corrections to be applied to obtain the true central altitude, will be given hereafter.

escopes, the one representing the objects erect or in their natural situation, the other inverting them, the eye glass being fixed in a moveable tube in order to adjust the telescope to a proper focus. By means of these telescopes the line of sight may be rendered parallel to the plane of the instrument, and the contact of the limbs of any two objects more accurately observed. The tube, or either telescope, is to be screwed into a brass ring, which is connected with another brass ring, by means of two screws, and by loosening one and tightening the other, the axis of the tube, or telescope, may be set parallel to the plane of the instrument. One of these rings is fixed to a brass stem that slides in a socket, and by means of the screw L at the back of the sextant, it may be raised or lowered so as to move the axis of the telescope to point to that part of the horizon glass judged the most fit for observation.

A circular head, containing a plate, in which there are three coloured glasses, and a part that is open, sometimes accompanies the sextant: this head is to be screwed on the eye end of the tube, or on that of either telescope. The edge of the plate projects a little beyond the head on one side, and is moveable by the finger, so that the open ring or any of the coloured glasses, may be brought between the eye glass of the telescope and the eye; this answers the purpose of the dark glasses placed at E, in adjusting by the sun, or observing by an artificial horizon on land.

To these are added a small screw driver, to adjust the screws, and a magnifying glass to read off the observation with greater accuracy.

The adjustments of a sextant are similar to those of a quadrant; the index and horizon glasses must be perpendicular to the plane of the instrument, and their planes parallel to each other when the index stands on 0; also the axis of the telescope must be set parallel to the plane of the instrument: each of these particulars must be examined before an observation is taken, and the adjustments, if requisite, made according to the following directions.

1st. *To set the index glass perpendicular to the plane of the instrument.*

Move the index forward to about 60°, and proceed exactly in the manner prescribed for the adjustment of the index glass of a quadrant, page 91.

2d. *To make the horizon glass perpendicular to the plane of the Sextant.*

This adjustment is made exactly in the same manner, as that of the quadrant described in page 91, except that instead of looking through the sight vane, you may use the tube or a telescope.

To make the horizon glass and index glass parallel when the index is on 0.

Having made the foregoing adjustments, set the first division on the index to 0 on the limb, fasten the index in this position, and make the coincidence of these divisions as perfect as possible, by means of the tangent screw, the eye being assisted by the magnifying glass; screw the tube, or telescope, into its support, and turn the screw L at the back of the instrument, till the line which separates the transparent and silvered parts of the horizon glass appears in the middle of the tube or telescope; having done this, hold the plane of the sextant vertically and direct the sight through the tube or telescope to the horizon; then if the reflected and true horizons do not coincide, turn the tangent screw at the back of the horizon glass till they are made to appear in the same straight line. Then will the horizon glass be adjusted.

After the screw that retains the horizon glass in its place, is fastened, it will be proper to re-examine this adjustment; if the coincidence of the horizons is not perfect, the adjustment must be repeated till it is so; but as it is difficult to obtain a perfect coincidence by this means, the horizons may be brought to coincide by turning the tangent screw of the index, and the difference between the 0 on the arch and the 0 on the vernier will be the index error, which is additive to all observations, if the 0 of the index stand on the

extra arch, otherwise subtractive. The index error may also be found, very accurately, by measuring the diameter of the sun twice, with a motion of the index in contrary directions; that is, first bring the upper limb seen by reflection to coincide with the lower limb seen directly, then bring the lower limb by reflection to coincide with the upper seen directly. If both these measures are taken either to the right or left of 0 on the limb, half their sum will be the index error; additive if to the right of 0; subtractive, if to the left; but if one of the measures be taken to the right, and the other to the left of 0, half their difference will be the index error, which will be additive when the diameter measured to the right of 0 exceeds that measured to the left, otherwise subtractive. Thus if the measures were 38′ to the left of 0 on the arch, and 26′ to the right* on the extra arch, half the difference or 6′ would be the correction, subtractive. In some sextants the horizon glass cannot be adjusted; the index error must in that case be found, and must be considered as a constant quantity to be applied to all angles measured with the same instrument.

To set the axis of the telescope parallel to the plane of the Sextant.

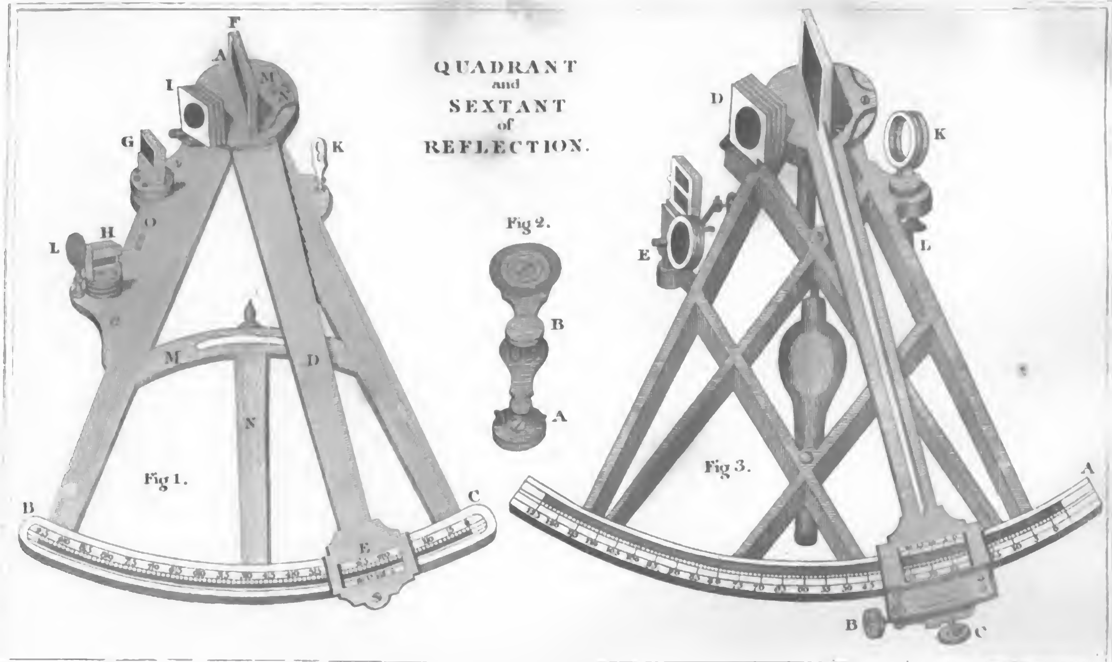
In measuring angular distances, the line of sight, or axis of the telescope, should be parallel to the plane of the instrument, as a deviation in that respect, in measuring large angles, would occasion a considerable error: to avoid which, a telescope is made use of, in which are placed two wires, parallel to each other, and equidistant from the centre of the telescope, by means of which, the adjustment may be made in the following manner.—Screw on the telescope and turn the tube containing the eye glass, till the wires are parallel to the plane of the instrument; then take two objects, as the sun and moon, whose angular distance must not be less than 90°, because the error is more easily discovered when the distance is great: bring them exactly into contact at the wire nearest the plane of the sextant, and fix the index; then, by altering a little the position of the instrument, make the image appear on the other wire; if the contact still remains perfect, the axis of the telescope is in its right situation; but, if the limbs of the two objects appear to separate or lap over, at the wire which is farthest from the plane of the sextant, the telescope is not parallel, and it must be rectified by turning one of the two screws of the ring into which the telescope is screwed and fixed, having previously unturned the other screw: by repeating this operation a few times, the contact will be precisely the same at both wires, and the axis of the telescope will be parallel to the plane of the instrument.†

In order to estimate the error committed in not observing the contact of the objects in the middle between the two parallel wires of the telescope, it is necessary to know the angular distance of these wires: this may be found as follows: Turn round the eye piece of the telescope, till the wires are perpendicular to the plane of the instrument: hold the instrument in a vertical position, and move the index till the direct and reflected images of the horizon appear in the same line, which will happen when the index is at 0 if the instrument be well adjusted; then move the index till the reflected image of the horizon be at one wire and the directed image at the other; the angle moved through by the index, as shown by the divisions of the arch, will be the an-

* In reading off the measure on the extra arch, you must reckon the minutes on the vernier from left to right, counting 19′ as 1′, 18′ as 2′, &c. or else take the difference between the minutes denoted by the vernier and 20′. Thus if the angle on the extra arch appeared by the nonius to be 14′ the real angle would be only 6′.

† This adjustment may be made in a manner similar to that by which the graduation on the frame of the telescope of a circular instrument is verified by using the adjusting tools of a circle or a ruler whose surfaces are perfectly parallel to each other. Thus, lay the sextant horizontally on a table, and place the ruler on the limb or plane of the instrument, and, at about 12 or 15 feet distance, let a well defined mark be placed in a range with the telescope, so as to be in the same straight line with the top of the ruler, then raise or lower the telescope by means of the screw L, till the centre of the eye piece of the telescope be at the same height as the top of the ruler, then if the mark be seen in the middle between the wires of the telescope, it is well adjusted; if not, it must be altered by means of the screws of the ring into which the telescope is screwed.

QUADRANT
and
SEXTANT
of
REFLECTION.



gular distance of the two wires. This angular distance being obtained, the observer may, by means of it, estimate, at each observation, how much the place where the contact was observed, was elevated above, or depressed below, the plane passing through the eye and the middle line between the two parallel wires; the correction in Table XXXV. corresponding to this angle, is to be subtracted from the observed angular distance of the objects; thus if the distance between the wires was 3°, one of them would be elevated above the plane 1° 30′, and the other depressed as much below it; and if in taking an observation, the point of contact was estimated to be one-third part of the distance from the middle towards either wire, the angle of elevation or depression would be one-third part of 1° 30′ or 30′; and if the observed distance was 100°, the correction in Table XXXV. would be 19″, subtractive from the observed angle, which would therefore be 100°—19″= 99° 59′ 41″. In general it will not be necessary to attend to this correction.

To measure the distance between the Sun and Moon.

Screw on the telescope, and place the wires parallel to the plane of the instrument; then if the index glass is half silvered and half blacked, and the sun very bright, raise the plate before the silvered part of the glass, and with the screw L raise the telescope to the transparent part of the horizon glass; turn down one or more of the dark glasses according to the brightness of the sun; then hold the sextant so that its plane may pass through the sun and moon; if the sun be to the right hand of the moon, the sextant is to be held with its face upwards; if to the left hand, the face is to be held downwards: with the instrument in this position, look directly at the moon through the telescope, and move the index forward till the sun's image is brought nearly into contact with the moon's nearest limb; then fix the index by the screw under the sextant, and make the contact perfect by means of the tangent screw; at the same time move the sextant slowly, making the axis of the telescope the centre of motion, by which means the objects will pass each other, and the contact be more accurately made, observing that the point of contact of the limbs must always be observed in the middle between the parallel wires. The observation being thus made, the index will point out the distance of the nearest limbs of the sun and moon.

To measure the distance between the Moon and a Star.

Turn down the green screen if the moon is bright, and direct the plane of the instrument through both objects, with its face upwards, if the moon is to the right of the star; but if to the left, the face is to be held downwards; look at the star through the telescope and transparent part of the horizon glass, and move the index till the moon's image appears nearly in contact with the star: fasten the index, move the sextant round the axis of the telescope as in measuring the distance of the sun and moon, and turn the tangent screw, till the coincidence of the star and the *enlightened or round limb* of the moon is perfect; observing that the point of contact of the limb of the moon and star must always be in the middle between the parallel wires. The observation being thus made, the index will point out the distance of the enlightened limb of the moon from the star, whether it be the farthest or nearest limb.

If the observer suspect that the mirrors, or coloured glasses, have not their surfaces exactly parallel, he may verify them as follows:—

Verification of the parallelism of the Index glass.

This verification is to be made ashore, by observing the angular distance of two well defined objects, whose distance exceeds 90° or 100° (having previously well adjusted the instrument) then taking out the central mirror and turning it, so that the edge which was formerly uppermost may now be nearest the plane of the instrument; rectify its position and again measure the distance of the two objects; half the difference between these two distances will be the error of the observed angle arising from the defect of pa-

rallelism of the central mirror. If the first distance exceeds the second, the error is subtractive, otherwise additive, the mirror being in its first position; but the contrary when in its second position. Thus, if the first distance was 119° 59′ 21″ and the second 120° 0′ 39″, the error would be 39″, additive when the mirror was in its first position, subtractive for the second. The error for any other angle may be found by means of col. 2d. Table XXXIV. when the inclination of the plane of the horizon glass to the axis of the telescope is 80°, by saying, as the tabular correction corresponding to 120° (=4′ 5″) is to the error of the glass 39″, so is the tabular error for any other angle as 85° (=1′ 15″) to the corresponding error of the glass 12″. In this manner a table of errors may be made for all angles.*

The angle between the plane of the horizon glass and axis of the telescope produced, being constant in all observations and adjustments of the sextant, no error can arise from the want of parallelism of its surfaces.

Verification of the parallelism of the surfaces of the coloured glasses.

Turn down the glass at D, which is to be examined, and another at E, to defend the eye from the sun; direct the telescope to the sun and move the index till its direct and reflected images coincide; then turn the dark glass at D, so that the surface which was farthest from the horizon glass may now be nearest to it, and if the contact of the same two limbs be complete, the surfaces of this glass are parallel, but if they lap over, or separate, the index must be moved to bring them again in contact, then half the arch passed over by the index will be the error, arising from the want of parallelism of the glass at D.

DESCRIPTION AND USES

OF THE

CIRCLE OF REFLECTION.

THE Circle of Reflection was invented by the celebrated professor MAYER of Groningen, and has since been greatly improved by the CHEVALIER DE BORDA, MR. TROUGHTON, and MR. MENDOZA Y RIOS. In its present improved state it has a decided superiority over the sextant in measuring the distance of the moon from the sun, or a star, on account of its correcting, in a great measure, the errors arising from a faulty division of the limb, want of parallelism in the surfaces of the mirrors and coloured glasses, and entirely avoiding the error which might arise in a sextant from the mirrors not being parallel when the index is on 0.

Fig. 1. Plate VIII. represents the Circle of Reflection, as given by DE BORDA; in fig. 2 is a section of the same instrument, marked with the same letters of reference as in fig. 1. The principal parts of this instrument are, the circular limb LMV; the central index EF; the horizon index MD; the central glass or mirror A; the horizon glass or mirror B; the telescope GH; the coloured glasses fig. 3, 4; the handle fig. 5; the ventelle fig. 6; and the adjusting tool fig. 7.

The *limb of the instrument* LMV, is a complete circle of metal, and is connected with a perforated central plate by six radii; it is divided into 720° because of the double reflection; each degree is generally divided into three equal parts, and the division is carried to minutes, or lower, by means of the verniers of the two indices.

The *two indices* are moveable round the same axis, which passes exactly through the centre of the instrument; the central index EF carries the cen-

* The method of calculating the above tabular numbers when the angle of inclination of the telescope and horizon glass differs from 80° is given in the explanation of Table XXXIV. prefixed to the tables.

tral mirror A; and the horizon index MD carries the telescope GH and the horizon mirror B; both indices are furnished with verniers and tangent screws at O and N.

The *central mirror* A is placed on the central index immediately above the centre of the instrument; the plane of this mirror makes an angle of about 30° with the middle line of the index, and is adjusted perpendicular to the plane of the instrument, by means of the screws placed on the back part of the frame of the mirror.

The *horizon glass* B is placed on the horizon index near the limb, so as to interfere as little as possible with the rays proceeding from objects situated on the opposite side of that index with respect to the central mirror. The horizon glass is adjusted perpendicular to the plane of the instrument in a similar manner to that of the horizon glass of a sextant: and in some circles this mirror is moveable about an axis perpendicular to the plane of the instrument, by which means the situation with respect to the telescope may be adjusted.

The *telescope* GH, attached to the other end of the horizon index, is an astronomical one inverting the observed objects, and has two parallel wires in the common focus of the glasses, distant from each other between two and three degrees. These wires, at the time of observation, must be placed parallel to the plane of the instrument: To effect this, marks are made on the eye-piece, and on the tube at G, and by making them coincide, the wires may be brought to their proper position. The telescope may be raised or depressed by two screws I, K, so as to be directed to any part of the horizon glass; and, by means of the graduations on the swo standards *i*, *k*, the telescope may be rendered parallel to the plane of the instrument.

There are two sets of *coloured glasses* (fig. 3, 4) each set usually containing four glasses of different shades; the glasses of the larger set (fig. 4) which are placed before the central mirror at *a*, *a*, should have each about half the degree of shade with which the corresponding glasses (fig. 3) of the other set, placed at C, are tinged, because the rays from the luminous object pass twice through the coloured glass placed before the central mirror, and only once through the other. The glasses placed at *a*, *a*, are kept tight in their places by small pressing screws at their ends, or by slides passing in front, through perforations in the stems of their frames: when fixed for observation they make an angle of about 85° with the plane of the instrument, by which means the image from the coloured glass is not reflected to the telescope. When the angle to be measured is between 5° and 85°, one of the largest set is to be fixed at *a*, *a*; in other cases, one of the smaller set is to be placed in the socket C. The reason of using the large glass is this—when the small glass is placed at C, it intercepts the direct light of the luminous object in its passage towards the central mirror, if the object happens to be situated within the angular space, included by the lines from the centre A, by the sides of the frame of the glass placed at C. This is avoided by using the larger glasses.

The *handle* (fig. 5) is of wood, and is fixed to the back of the instrument immediately under the centre. By this it is held during the time of observation.

The *ventelle* (fig. 6.) is used in terrestrial observations to diminish the light of the object seen directly, to render it equal in brightness to that of the objects seen by reflection: this is performed by putting the ventelle in the socket D, and raising or depressing it till the objects appear of equal brightness.

There are two *adjusting tools* of the form represented in fig. 7; they are exactly of the same size, and their height is nearly equal to that of the central mirror; they may be used in adjusting the central mirror perpendicular to the plane of the instrument, and in making the axis of the telescope parallel to that plane.

The instrument, as we have now described it, is the same as it was left by De Borda; Mr. Troughton has since suggested the improvement of fixing to the horizon index the arch WSPR, and providing it with two sliding pieces U, X, in order to facilitate the fixing the indices at their proper

angles with each other in taking successive observations. When the central and horizon glasses are parallel, the central index covers the space SP of the arch, and the spaces SW, PR, are each divided into degrees from S to W, and from P to R, and numbered 0 at S and P, and continued to 130° towards W and R. The use of this arch and sliding pieces will be explained hereafter.*

That ingenious mathematician and navigator, M. Mendoza y Rios, has further improved the circular instrument by the substitution of a circular ring (moving round the centre of the instrument over or adjacent to the limb TMV) for a vernier instead of those attached to the indices by De Borda: and by fixing this circular vernier alternately to each of the indices it serves as a vernier for both, and after any number of observations, gives the compound motion of both indices, and thus double the number of distances are obtained by this instrument that can be obtained by De Borda's circle with the same number of observations. Mr. Rios has also improved the form of the handle for holding the instrument. In theory the instrument, as improved by Mr. Rios, appears to be superior to that of De Borda, but not having used one of the former kind, I cannot, from my own experience, decide whether it is so much superior in practice; but Mr. Rios says that he found it answered his expectations. As the method of taking the observation is nearly the same with both instruments, I shall confine myself to the explanation of the uses of De Borda's, from which the method of using the other will be easily discovered.

Adjustments of the Circle of Reflection.

Before entering upon an explanation of the adjustments of this instrument, it will be proper to premise that there are three different methods of observing the angular distance of two objects with this instrument, viz. (1) by what is called an observation to the right, (2) by an observation to the left, and (3) by a cross observation.

An observation to the right is that, where the object, whose image is to be reflected and the central mirror are on the same side of the telescope. *An observation to the left,* when the object to be reflected and the central mirror are on opposite sides of the telescope, which in both cases is supposed to be directed to the other object; *and a cross observation* is a combination of the fore-mentioned observations; the first being generally taken to the left, and the second to the right.

The adjustments of a circle consist in placing the mirrors perpendicular to the plane of the instrument, and in making the axis of the telescope parallel to that plane. These are all the adjustments necessary in measuring an angular distance by cross observations; but if one observation only be taken to the right, or to the left, it will be necessary to find the division, on which the horizon index must be placed, to make the horizon glass parallel to the central glass, when the central index stands on 0. These adjustments are similar to those of a sextant, but a particular explanation of each will here be given.

To set the central glass perpendicular to the plane of the instrument.

This adjustment may be made by placing the eye in front of the central glass at L, a little above the plane of the instrument, and observing if the reflected image of that part of the limb nearest the eye appears to make one continued circular line with the parts of the limb towards T, seen to the

* Mr. Troughton suggested another alteration in the circle, but (as Mr. Rios justly observes) the instrument thus altered may be considered as a sextant, the limb of which is completed to the whole circumference. A circle of this description is usually furnished with three indices and verniers, by each of which every observation must be read off. This is very troublesome, particularly in the night. It is true that this method corrects in a very great degree the error of not having the index fixed exactly on the centre, or that of not having an instrument perfectly circular; but errors of this kind in Borda's circle may be reduced in any ratio by taking a number of observations, and the error will in general be extremely small in taking a sufficient number to bring the index nearly to the point set out from: so that in those important points I should, on the whole, prefer an instrument of Borda's construction.

right and left of the central glass; for in this case the glass is perpendicular to the plane of the instrument; otherwise it must be adjusted by means of the screws till the two images coincide.*

By examining this adjustment in different parts of the limb, it will be known if the limb be in the same plane. If any difference should be found, the central glass must be so fixed that the reflected image of the limb may appear as much above the direct image in some places as below it in others.

To set the horizon glass perpendicular to the plane of the instrument.

The central glass being previously adjusted, and the telescope directed to the line separating the silvered from the transparent part of the horizon glass, hold the instrument nearly vertical, and move either index till the direct and reflected image of the horizon, seen through the telescope, coincide; then incline the instrument till it is nearly horizontal, and if the images do not separate, the horizon glass is perpendicular to the plane of the instrument; but if they do separate, the position of the glass must be rectified by means of the screws in its pedestal.

This adjustment may be also made by directing the sight through the telescope to any well defined object; then, if by moving the central index, the reflected image passes exactly over the object seen directly, the glass is perpendicular, otherwise its position must be adjusted by means of the screws attached to the pedestal of the glass.

A planet, or star of the first magnitude, will be a good object for this purpose. If the sun is used, one of the coloured glasses must be placed at C and another at D.

To make the axis of the telescope parallel to the plane of the instrument.

The telescope may be raised or depressed by means of two screws attached to the standards *i*, *k*, (fig. 2) and passing through two pieces of brass connected with the tube of the telescope. On each of these pieces is a mark or index by which the telescope is to be adjusted, for, by bringing the indices to the same mark on each standard, the telescope will be parallel to the plane of the instrument.†

To find that division to which the horizon index must be placed to render the mirrors parallel when the central index is on 0.

Place the central index on 0; direct the telescope to the horizon glass, so that the line joining the silvered and transparent parts of that glass may appear in the middle of the telescope; hold the instrument vertically, and move the horizon index, till the direct and reflected horizons agree, and the division shown by the horizon index will be that required.

This adjustment may also be made by measuring the diameter of the sun in contrary directions; thus, the central index being fixed on 0, place a dark glass at C and another at D; direct the telescope (through the transparent part of the horizon glass) to the sun, and move the horizon index, till his reflected image appear in the telescope; bring the upper edge of the direct image to coincide with the lower of the other, and note the angle shown by the index; then, by moving the horizon index, bring the lower edge of the

* When the instrument is furnished with adjusting tools, this adjustment may be made in the following manner. Set the two tools on opposite parts of the limb at T and L; place the eye at *e*, at nearly the same height as the upper edge of the tools, so that part of the tool at T may be hid by the central glass; move the central index till the reflected image of the tool nearest the eye appears in the central glass at the side of the other tool seen directly; then if the upper edges of the tools are apparently in the same straight line, the central glass is perpendicular to the plane of the instrument, otherwise its position must be adjusted by the screws at the back of the frame.

† If you suspect that the marks on the standards are inaccurate, you may examine them in the following manner. Lay the circle horizontally on a table; place the two adjusting tools on opposite parts of the limb at T and L; and at about 12 or 15 feet distance let a well defined mark be placed, so as to be in the same straight line with the tops of the tools; then raise or lower the telescope till the mark is apparently in the middle between the two wires; then the axis of the telescope will be parallel to the plane of the instrument, and the difference (if any) between the divisions pointed out by the indices on the graduation of the standards *i*, *k*, (fig. 2) will be the error of the indices, by knowing which, it will be easy in future adjustments to make allowance for the error.

direct image to coincide with the upper edge of the reflected one, and note also the angle pointed out by the index; half the sum of these two angles will be the point of the limb where the horizon index must be placed to render the mirrors parallel. Thus, if the index in the first observation stood on 473° 30′, and in the second on 474° 34′, the half sum of the two 474° 2′ would be the point where the horizon index must be placed to make the mirrors parallel.

These are all the adjustments necessary to be made preparatory to measuring any angular distance.* When the angle is measured by cross observations, the error arising from the want of parallelism of the surfaces of the mirrors, and screens, will in general be very small; however, the method of verifying those glasses and making allowance for any error in them will be given hereafter.

To observe the meridian altitude of any celestial object, either by an observation to the right or to the left.

The method of observing the meridian altitude of an object with a circle is exactly similar to that with a quadrant or sextant. The central index must be fixed on 0, and the horizon index on the point which renders the two mirrors parallel; then the altitude may be taken either by an observation to the right or to the left; but the former method, in which the large coloured glasses are not necessary, is in general to be preferred; because those large glasses are more liable to cause an error in the observation than the small ones.

If an observation to the right is to be taken, a small dark glass must be placed at C, if the object be bright, then hold the instrument in the right hand in a vertical position; move the central index, according to the order of the divisions of the limb, till the reflected image of the object, seen in the telescope, nearly touches the direct image of the horizon; tighten the index by the screw at the back of the instrument; make the contact complete in the middle between the parallel wires of the telescope, by the tangent screw, and by sweeping, exactly in the same manner, as when observing with a quadrant, and the central index will point out the altitude of the object.

If an observation to the left is taken, and the object be bright, a large dark glass must be placed at *a a*, if the altitude be between 5° and 35°; otherwise a small glass at C; hold the instrument in the left hand, in a vertical position, move the central index contrary to the order of the divisions, and bring the reflected image in contact with the horizon as above: the angle shown by the central index being subtracted from 720°, will be the sought altitude.

In both these methods of observing the meridian altitude of an object, the circle, the radius of which is only five inches, will hardly be so accurate as a good sextant of a larger radius: but, by the help of a well regulated watch, the meridian altitude may be obtained, by the circle, to a much greater degree of accuracy than by a sextant, by observing in the following manner. A few minutes before the object passes the meridian, begin to observe the altitude by cross observations (in the manner to be described in the next article) and note the time of each observation by the watch: continue to observe till a few minutes after the object has passed the meridian: then the angles shown by the central index being divided by the whole number of observations, will give the approximate meridian altitude; the correction to be applied to it to obtain the true meridian altitude, may be found by means

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* In some instruments there is an adjustment of the horizon glass, to place it at its proper angle with the axis of the telescope; if an adjustment of this kind is necessary, it ought to be made before the other adjustments, in such manner, that if a coloured glass be fixed at C, none of the rays from the central glass can be reflected to the telescope from the horizon glass without passing the coloured glass. To effect this, the *ventelle* must be placed at D, and lowered so as to intercept the direct light entirely; then place the coloured glass at C, and direct the telescope to the silvered part of the horizon glass; move the central index, and if no uncoloured images appear (reflected from the central glass) but all have the same tinge as that of the coloured glass used, the horizon glass is in its proper position; otherwise it must be turned on its axis till the uncoloured images disappear.

of Tables XXXII. and XXXIII. by a method which will be explained hereafter, when treating of finding the latitude by a single altitude of the sun.

In this article the meridian altitude has only been spoken of, though it is evident that the method is applicable to an object not on the meridian; but in this case the cross observations, which give to the circle all its advantages, may be used, and the mean of the altitudes taken instead of a single altitude; this method is peculiarly adapted to the taking of altitudes for regulating a watch, for which reason it will be particularly explained in the following article:—

To take altitudes of the sun or any celestial object, by cross observations, for regulating a watch.

Fix the central index on 0, and if the object be bright and the altitude between 5° and 35° place a large coloured glass before the central glass, at *a a*, otherwise a small one at C; hold the instrument in the left hand, in a vertical position; move the horizon index till the image of the reflected object be brought in complete contact with the horizon, in the middle between the two parallel wires of the telescope, as directed in the preceding article, and note the time of observation by the watch; then fasten the horizon index; hold the instrument in the right hand, in a vertical position, move the central index according to the order of the divisions, till the reflected image be again brought into complete contact with the horizon* as above, and note the time of observation. Then half the sum of the times, and half the angle shown by the index, will be a mean time, and a mean altitude corresponding thereto.

Times of obs.	Angle.
4h. 20.′ 0.″	
4. 21. 10.	
4. 22. 15.	
4. 23. 0.	
4. 24. 45.	
4. 25. 30.	
6) 26. 16. 40.	6) 60° 24′
4. 22. 47.	10. 4

If greater accuracy be required, the observation must be repeated, setting out from the points where the indices then are, and observing in the same manner by moving first the horizon index, then the central one; continue taking as many of these cross observations as are judged necessary, and note the times of each observation: Then the sum of the times, divided by the whole number of observations, will be a mean time; and the angle shown by the central index, divided by the number of observations, will be a mean altitude corresponding thereto. Thus, if six observations were taken, and the times noted as in the adjoined table, the angle shown by the index being 60° 24′, the mean time would be obtained by dividing the sum of the times 26h. 16′ 40″ by 6, and the mean altitude by dividing 60° 24′ by 6; therefore the mean time would be 4h. 22′ 47″ and the mean altitude corresponding 10° 4′.

To measure the distance between the sun and moon, by a circular instrument.

The instrument being well adjusted, fix the central index on 0, and if the object be bright, place a small dark glass at C; hold the instrument so that its plane may be directed to the objects, with its face downwards when the sun is to the right of the moon: otherwise, with its face upwards; direct the sight through the telescope to the moon; move the horizon index according to the order of the divisions of the limb, till the reflected image of the sun appears in the telescope, and the nearest limbs of the sun and moon are almost in contact: fasten the index, and make the coincidence of the

* The arch described on the limb by the central index will be equal to twice the altitude of the object, or twice the angle passed over by the other index: if more cross observations be taken, each of the indices, when moved, will describe an arch equal to double the altitude of the object: the same is to be observed in measuring any other angular distance. If the instrument is furnished with the arch WSR, and sliding pieces U, X, you must bring the slide X to the central index after taking the first observation to the left, and place the slide U at the same degree on the arch SW that X is on the arch PR; then, in the next observation, the central index is to be brought to touch the slide U; in the next observation to the left the slide X is to be brought to the central index, and so on for the other observations. Thus, by means of the slides, the indices may be placed at nearly their proper angles with each other at the beginning of the observation, which will save considerable time. After being thus fixed, the contact must be completed by means of the tangent screw of the index, which is to be moved.

limbs perfect, in the middle between the two parallel wires of the telescope. by means of the tangent screw of the horizon glass, and note the time of observation, then invert the instrument, and move the central index, according to the order of the divisions of the limb, by a quantity equal to twice the arch passed over by the horizon index (or twice the distance of the sun and moon;*) direct the plane of the instrument to the objects; look directly at the moon, and the sun will be seen in the field of the telescope: fasten the central index, and make the contact of their nearest limbs complete, in the middle between the two parallel wires of the telescope, by means of the tangent screw of the central index, and note the time of observation; then half the arch shown by the central index will be the distance of the nearest limbs of the sun and moon, and half the sum of the times will be the mean time of observation.

Having finished these two observations, two others may be taken in the same manner, setting out from the points where the indices then are, and moving first the horizon index, then the central index: proceed thus, till as many observations as are judged necessary be taken, always observing that the number of them be even; then the angles shown by the central index (or that angle increased by 720°, or 1440°, &c. if the index has been moved once or twice, &c. round the limb) being divided by the whole number of observations, will give the mean distance, and the sum of all the times divided in like manner will be the mean time of observation.

To measure the distance between the moon and star, by a circular instrument.

Fix the central index on 0, and if the moon be bright, and the distance between 5° and 35°, place a large green glass before the central mirror at *a a*. otherwise a small one at C; hold the instrument so that its plane may be directed to the objects, with its face downwards when the moon is to the right of the star, otherwise with its face upwards; direct the sight through the telescope to the star; move the horizon index, according to the order of the divisions of the limb, till the reflected image of the moon appears in the telescope, and the enlightened limb of the moon be nearly in contact with the star; fasten the index, and make the coincidence perfect, in the middle between the parallel wires of the telescope, by means of the tangent screw belonging to that index, and note the time of observation; then invert the instrument, and move the central index, according to the order of the divisions of the limb, by a quantity equal to twice the arch passed over by the horizon index;* direct the plane of the instrument to the objects, look directly at the star, and the moon will be seen in the field of the telescope; fasten the central index, and make the contact of the enlightened limb of the moon and the star complete, in the middle between the two parallel wires of the telescope, by means of the tangent screw of that index, and note the time; then half the arch shown by the central index will be the distance of the star from the enlightened limb of the moon, and half the sum of the times will be the mean time of observation; these two observations being completed, others may be taken in the same manner, according to the directions above given for measuring the distance of the sun from the moon.

In continuing to take these cross observations by a circle furnished with the arch WSR, and slides U, X, it will be very easy to bring the reflected image into the field of the telescope; but if the instrument is not thus furnished, it will be often difficult to bring the image into the field of the telescope, and much time will be lost, and the observations rendered tedious by that means; to remedy this, a small table of the angles at which each index should be placed, ought to be made before beginning the observation: this table is easily formed, as follows: find roughly according to the directions heretofore given, the point at which the horizon glass must be placed to be parallel to the central glass, when the central index is on 0; then find what point of the arch the horizon index stands upon after measuring the first distance, as directed above; the difference between these

* This may be done expeditiously by means of the slides U, X, as was explained in the preceding note.

two points will be the angular distance of the objects; the double of this distance being successively added to 0°, and to the angle pointed out by the horizon index after the first observation, will give the points of the arch where the indices must be placed at the 2d. 3d. 4th. &c. observations. Thus, if the point of parallelism was 471° and the point where the horizon index was at the first observation, was 525°, the difference or 54° would be the angular distance; the double of which, or 108°, being added to 525° gives 633°, which is the point of the arch where that index must be placed at the third observation; 633° added to 108° gives 741° or 21° (because the divisions recommence at 720°) which is the point where the index must be placed at the fifth observation, &c. as in the adjoined Table. The central index being at first on 0°, after the second observation it will be on 108°, at the fourth on 108°+108°=216°, at the sixth on 216°+108°=324°, &c. Thus, by constantly adding 108°, or twice the distance of the objects, the angles, at which the indices must be placed, will be obtained; and by fixing them at these angles, the reflected image will be brought into the field of view without any trouble.*

Central Index.	Horizon Index.
0°	525
108	633
216	21
324	129
432	237
540	&c.
&c.	

Having explained the methods of adjusting and using the circle of reflection, it remains to show how to calculate the error arising from not observing the contact of the objects in the middle between the parallel wires of the telescope, and also to estimate the errors arising from the want of parallelism of the mirrors and coloured glasses. These verifications are much more necessary in a sextant than in a circle, and they may be in general neglected.

To estimate the error arising from not observing the contact of the objects in the middle between the parallel wires of the telescope.

To estimate that error, it is necessary to know the angular distance of the wires of the telescope, which may be thus determined.

Turn round the eye-piece of the telescope, till the wires are perpendicular to the plane of the instrument, and put the central index on 0; direct the telescope to any well defined object, at least 12 feet distant, and move the horizon index till the direct and reflected image of the object coincide; then make one of the wires coincide with the object, and turn the central index till the reflected image of the object coincides with the other wire—and the arch passed over by that index will be the angular distance between the wires. This angle being obtained, the observer must, by means of it, estimate, at each observation, how much the place where the contact was observed was elevated above, or depressed below the plane passing through the eye and the middle line between the two parallel wires of the telescope: the correction in Table XXXV. corresponding to this angle, is to be subtracted from the observed angular distance of the objects: thus if the distance between the wires was 2°, one of them would be elevated above that plane 1° and the other depressed below it, by the same quantity; if, in taking an observation, the point of contact was estimated to be one-third part of the distance from the middle towards either wire, the angle of elevation or depression would be one-third part of 1° or 20′; and if the observed distance was 120° the correction in Table XXXV. would be 12″ subtractive from the observed distance.

The correction for each observed distance being ascertained, in the above manner, the sum of them must be subtracted from the whole angle shown

* If the distance of the object varies during the observation, these angles will require correction as you proceed with the observations. Thus if the distance was increasing, and at the sixth observation it was found that the central index was on 326° instead of 324°, the increase being 2°, you must add 2° to the rest of the numbers in the Table, and place the horizon index at the seventh observation on 129°+2°=131° and the central index at the eighth observation at 432°+2°=434°, &c.

by the central index, and the remainder, divided by the whole number of observations, will be the mean distance.

Verification of the parallelism of the surfaces of the central mirror.

This verification is to be made ashore, by observing the angular distance of two well defined objects, whose distance exceeds 90° or 100°, having previously well adjusted the instrument; after taking several cross observations and finding the mean distance, take out the central mirror and turn it so that the edge which was formerly uppermost may now be nearest the plane of the instrument; rectify its position, and take an equal number of cross observations of the angular distance of the same two objects; half the difference between the mean of these, and that of the former, will be the error of the observed angle, arising from the defect of parallelism of the central mirror. If the first mean exceeds the second, the error is subtractive, otherwise additive, the mirror being in its first position; but the contrary when in its second position. Thus, if 10 observations were taken at each operation, and in the first the angle shown by the index, was 1199° 53½′, and in the second 1200° 6½′; by dividing by 10 the mean angles are found to be 119° 59′ 21″ and 120° 0′ 39″, the difference of which is 78″, the half of which or 39″ is the error of the mirror additive when it is in its first position, subtractive in the second. The error for any other angle may be found by col. 4. Table XXXIV. when the inclination of the plane of the horizon glass to the axis of the telescope is18°, by saying, as the tabular error corresponding to 120° that is 1′ 30″ is to the error found in the glass 39″ so is the tabular error for any other at 85° which is 0′ 28″, to the error of the glass corresponding 12″; and in this manner a table of errors may be made, not only for the cross observations, but also for the observations to the right or left.*

It may be remarked that the errors are much less in the cross observations than in the observations to the right, which are those made with a quadrant or sextant, so that the circle has, in this respect, greatly the advantage of those instruments.

The angle between the plane of the horizon glass and axis of the telescope produced, being nearly the same in all observations and adjustments of the circle, no sensible error can arise from the want of parallelism in the surfaces of that glass.

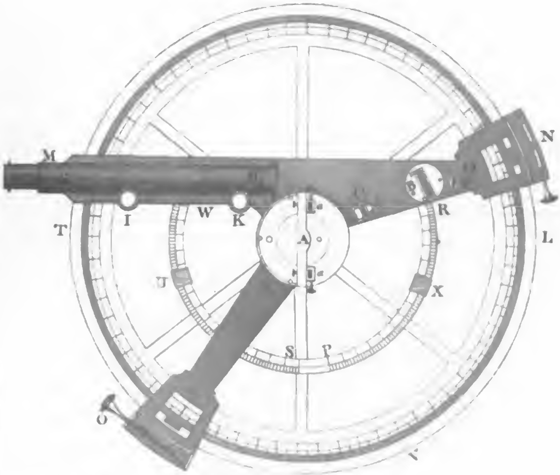
Verification of the parallelism of the coloured glasses.

Place one of the dark coloured glasses at C and another at D, fix the central index at 0, direct the telescope to the sun, and move the horizon index till the limbs of the direct and reflected image coincide; then turn the dark glass placed at C, so that the surface which was farthest from the horizon glass may now be nearest to it, and if the contact of the same two limbs be complete, the surfaces of the glass placed at C are parallel: but if the limbs lap over or separate, the central index must be moved to bring them again in contact, then half the arch passed over by that index will be the error arising from the want of parallelism of the glass C. If great accuracy is required, the operation may be repeated, by setting out from the point where the indices then are, and taking 4 or 6, &c. observations, then the arch passed over by the central index being divided by 4, 6, &c. will be the sought error. The other small glasses may be verified in the same manner; and by placing one of the larger glasses before the central index at *a a*, and one of the smaller ones at D, the former may be verified as above. The green glasses may be verified by observing the diameter of the full moon, or by some bright terrestrial object.

It may be remarked as one of the greatest advantages of the circle, that in measuring an angle by the cross observations, no error can arise from the

* If the inclination of the plane of the horizon glass and the axis of the telescope differ from 80°, you may find the tabular numbers by the method given in the explanation of Table XXXIV. prefixed to the Tables.

Fig. 1.



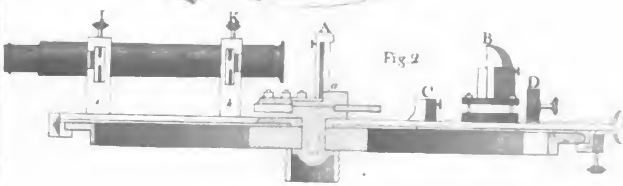


Fig. 2

Fig. 5.

Fig. 3.

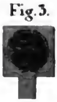


Fig. 4.

Fig. 6.

Fig. 7.

Hooker Eng.

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want of parallelism in the surfaces of the smaller dark glasses; for if those glasses give too great an angle by an observation to the right, they give too little by the same quantity by an observation to the left. It is not so with the larger glasses placed at *a a*, because the incidence of the rays on those glasses is more oblique in one observation than in the other, so that the errors do not wholly balance each other; however, as those glasses are used only in measuring angles less than 35°, in which the errors are nearly the same as if the incidence of the rays was perpendicular, the errors of those glasses will also nearly compensate each other in the cross observations; and if those observations only were used, it would be unnecessary to verify the dark glasses:—Even when taking observations to the right, or observations to the left, the error of the dark glasses would be destroyed, if the glass was turned at each observation, and the number of observations was even; but there are some cases in which an angle can only be measured by one observation, then it would be necessary to allow for the error of the dark glass, if the distance was required to be found within a few seconds.

ON PARALLAX, REFRACTION,

AND

DIP OF THE HORIZON.

PARALLAX (or diurnal parallax) is *the difference between the true altitude of the sun, moon, or star, if it were observed at the centre of the earth, and the apparent altitude observed at the same instant by a spectator at any point on the surface of the earth.*

Thus in Plate IX. fig. 3, let ABC be the earth, C its centre, A the place of a spectator, EDF part of the moon's orbit, *e d* G part of the orbit of a planet, and KZ part of the starry heavens. Then if at any time the moon be at D, she will be referred to the point H by a spectator supposed to be placed at the centre of the earth, and this is called the *true place* of the moon, but the spectator at A will refer the moon to the point *b*, and this is called the *apparent place* of the moon, the difference H *b* (or the angle HD*b*=ADC) is called the moon's *parallax in altitude*, which is evidently greatest when the moon is in the horizon at E, being then equal to the arch K I, and decreases from the horizon to the zenith and is there nothing. The parallax is less as the objects are farther from the earth: thus the parallax of a planet at *d* is represented by *a b*, being less than that of the moon at D: and the horizontal parallax K *f* of the planet is less than the horizontal parallax KI of the moon. As the parallax makes the objects appear lower than they really are, it is evident that the parallax must be added to the apparent altitude to obtain the true altitude. Having the horizontal parallax, the parallax in altitude is easily found by the following rule—*As radius is to the co-sine of the apparent altitude, so is the horizontal parallax to the parallax in altitude.* This rule may be easily proved: for in the triangle CAE we have CE : CA : : radius : sine CEA; and in the triangle CDA we have CD (or CE) : CA : : sine CAD : sine CDA; hence we have, radius : sine CEA : : sine CAD : sine CDA, but CEA=horizontal parallax, CDA=parallax in altitude, and sine CAD=co-sine app. alt. Hence we have radius : co-sine app. alt. : : sine hor. par. : sine par. in alt. but the parallaxes of the heavenly bodies being very small, the sines are nearly proportional to the parallaxes, hence we may say, as radius : co-sine app. alt. : : hor. par. : par. in alt.

The sun's mean parallax in altitude is given in Table XIV. for each 5° or 10° of altitude. The moon's horizontal parallax is given in the 7th page of the month of the Nautical Almanac, for every noon and midnight at the meridian of Greenwich.

REFRACTION OF THE HEAVENLY BODIES.

It is known by various experiments that the rays of light deviate from their rectilinear course in passing obliquely out of one medium into another of a different density, and if the density of the latter medium continually increase, the rays of light in passing through it will deviate more and more from the right lines in which they were projected towards the perpendicular to the surface of the medium: This may be illustrated by the following experiment: make a mark at the bottom of any bason or other vessel, and place yourself in such a situation that the hither edge of the bason may just hide the mark from your sight, then keep your eye steady, and let another person fill the bason gently with water: as the bason is filled, you will perceive the mark come into view, and appear to be elevated above its former situation. In a similar manner, the light in passing from the heavenly bodies through the atmosphere of the earth deviates from its rectilinear course, by which means those objects appear higher than they really are, except when in the zenith; this apparent elevation of the heavenly bodies above their true places, is called the refraction of those bodies. To illustrate this, let ABC (Fig. 2, Plate IX.) represent the atmosphere surrounding the earth DEF, and let an observer be at D, and a star at *a*, then if there were no refraction, the observer would see the star according to the direction of the right line D *a*, but as the light is refracted, it will, when entering the atmosphere near A, be bent from its rectilinear course, and will describe a curve line from A to D, and at entering the eye of the observer at D will appear in the line D *b*, which is a tangent to the curve at the point D, and the arch *ab* will be the refraction in altitude or simply the refraction, which must be subtracted from the observed altitude to obtain the true.

At the zenith the refraction is nothing, and the lesser the altitude the more obliquely the rays will enter the atmosphere, and the greater will be the refraction: at the horizon the refraction is greatest. In consequence of the refraction, any heavenly body may be actually below the horizon, when appearing above it. Thus when the sun is at T below the horizon, a ray of light TI proceeding from T comes straight to I, and is there, on entering the atmosphere, turned out of its rectilinear course, and is so bent down towards the eye of the observer at D, that the sun appears in the direction of the refracted ray above the horizon at S.

The mean quantity of the refraction of the heavenly bodies is given in Table XII. All observed altitudes of the sun, moon, planets, or other heavenly bodies, must be decreased by the numbers taken from that Table corresponding to the observed altitude of the object. The refraction varies with the temperature and density of the air, increasing by cold or greater density, and decreasing by heat and rarity of the atmosphere. The corrections to be applied to the numbers taken from Table XII. for different heights of Fahrenheit's Thermometer and the Barometer, are given in Table XXXVI.* Thus, if the refraction was required for the apparent altitude 5°, when the thermometer was at 20° and the barometer at 30,67 inches, we should have the mean refraction by Table XII. equal to 9′ 53″, and by Table XXXVI. the correction corresponding to the height of the thermometer 20° equal to + 48″, and for the barometer 30,67 equal to + 22″, hence the true refraction will be 9′ 53″ + 48″ + 22″ = 11′ 3″.

There is sometimes an irregular refraction near the horizon caused by the vapours near the surface of the earth; the only method of avoiding the error arising from this source, which is sometimes very great, is to take the observations at a time when the object which is observed is more than 10° above the horizon.

The refraction makes any terrestrial object appear more elevated than it really is; the quantity of this elevation varies at different times from $\frac{1}{7}$ to $\frac{1}{34}$

* This table is to be entered with the height of the Thermometer or Barometer at the top, and the apparent altitude at the side, under the former, and opposite the latter, will be the correction corresponding to the Thermometer or Barometer, which is to be applied to the mean refraction by addition or subtraction according to the signs at the top of the columns respectively.

of the angle formed at the centre of the earth, between the object and the observer, but in general this refraction is about $\frac{1}{14}$ of that angle.

DIP OF THE HORIZON.

Dip of the horizon is the angle of depression of the visible horizon below the true or sensible horizon (touching the earth at the observer) arising from the elevation of the eye of the observer above the level of the sea. Thus in Plate IX. Fig. 1. let ABC represent a section of the earth, whose plane produced passes through the observer and the object, and let AE be the height of the eye of the observer above the surface of the earth, then FEG drawn parallel to the tangent to the surface at A, will represent the true horizon, and EIH, touching the earth at I, will represent the apparent horizon;—therefore the angle FEH will be the dip of the horizon. Let M be an object whose altitude is to be observed by a fore observation by bringing the image in contact with the apparent horizon at H; then will the angle MEH be the observed altitude, which is greater than the angle MEF (the altitude independent of the dip) by the quantity of the angle FEH; so that in taking a fore observation the dip must be subtracted from the observed altitude to obtain the altitude corrected for the dip. In a back observation the apparent horizon is in the direction EK, and by continuing this line in the direction EL we shall have the observed altitude MEL, and it is evident that to this the dip LEF (=KEG) must be added to obtain the altitude corrected for the dip.

In Table XIII. is given the dip for every probable height of the observer expressed in feet. In calculating this table, attention was paid to the terrestrial refraction which decreases the dip a little, because IE becomes a curve line instead of a straight one, and EH is a tangent to that curve in the point E.

What has been said concerning the dip of the horizon supposes it free from all incumbrances of land or other objects; but as it often happens when ships are sailing along shore, or are at anchor in a harbour, that an observation is wanted when the sun is over the land, and the shore nearer the ship than the visible horizon would be if it were unconfined; in this case the dip of the horizon will be different from what it otherwise would have been, and greater the nearer the ship is to that part of the shore to which the sun is brought down. For this reason Table XVI. has been inserted, which contains the dip of the sea at different heights of the eye, and at different distances of the ship from the land. This table is to be entered at the top with the height of the eye of the observer above the level of the sea in feet, and in the left hand side column with the distance of the ship from the land in sea miles and parts; under the former, and opposite the latter, stands the dip of the horizon, which is to be subtracted from the altitude observed by a fore observation instead of the numbers in Table XIII.

The distance of the land requisite in finding the dip from Table XVI. may be found nearly in the following manner—Let two observers, one placed as high on the main-mast as he can conveniently be, and the other on the deck immediately beneath him, observe at the same instant the altitude of the sun or other object that may be wanted, and let the height of the eye of the upper observer above that of the lower be measured in feet and multiplied by 0,56, and the product, divided by the difference of the observed altitudes of the sun in minutes, will be the distance in sea miles, nearly.

Thus, if the eye of the upper observer was 68 feet higher than that of the lower, and the two observed altitudes of the sun 20° 0′ and 20° 12′ the distance of the land in sea miles would be 3,2. For $68 \times 0{,}56 = 38{,}08$ and this divided by the difference of the two observed altitudes of the sun 12′ gives 3,2 nearly. Now if the lower observer was 25 feet above the level of the sea, the dip corresponding to this height and the distance 3,2 miles would be 6′, which subtracted from 20° 0′ leaves 19° 54′ the altitude corrected for the dip.

The dip may be calculated in this kind of observations to a sufficient degree of accuracy without using Table XVI. in the following manner—Divide

the difference of the heights of the two observers in feet by the difference of the observed altitude in minutes, and reserve the quotient. Divide the height of the lower observer in feet by this reserved number, and to the quotient add one quarter of the reserved number, and the sum will be the dip in minutes corresponding to the lower observer. Thus in the above example $\frac{68}{12}=5',6$ is the reserved number, and $\frac{25}{5,6}=4.4$, to this add one fourth of 5'.6 or 1'.4 and the sum will be the dip 5'.8 or nearly 6' corresponding to the lower observer, being the same as was found by the table.

TO FIND THE SUN'S DECLINATION.

THE declination of the sun is given to the nearest minute in Tab. IV. for every noon at Greenwich, from the year 1824 to 1838; and this table will answer for some years beyond that period, without any material error; if great accuracy is required, the declination may be taken from the second page of the month of the Nautical Almanac.* This declination may be reduced to any other meridian, by means of Table V. in the following manner.

To find the sun's declination at noon, at any place.

RULE. Take out the declination at noon at Greenwich from Table IV. (or from the Nautical Almanac;) then find the longitude from Greenwich in the top column of Table V. and the day of the month in the side column; under the former, and opposite to the latter, will be a correction in minutes and seconds, to be applied to the declination taken from Table IV: to know whether this correction be additive or subtractive, you must look at the top of the column where you found the day of the month, and you will see it noted whether to add or subtract, according as the longitude is east or west. This correction being applied, you will have the declination at noon at the given place.

EXAMPLE I.

Required the declination of the sun at the end of the sea-day, October 10, 1824, in the longitude of 114° E. from Greenwich?

Sun's declination Oct. 10, at Greenwich, at the end of the sea-day or beginning of the day in the N. A. by Tab. IV.	6°	44'	S.
Variation of Dec. Tab. V. Oct. 10, in 114° E. long. sub. . . .	0	7	
True dec. noon, Oct. 10. in long. 114° E.	6	37	S.

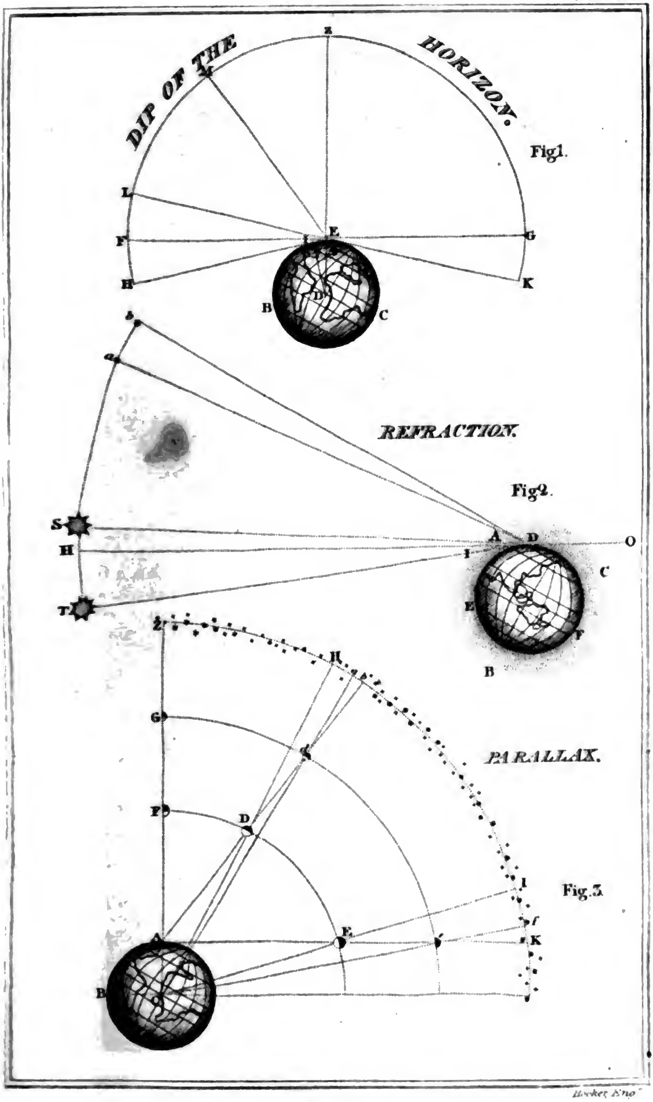
EXAMPLE II.

Required the sun's declination at noon ending the sea-day of March 12, 1824, in the longitude of 75° W. from Greenwich?

Sun's declination March 12, by Tab. IV.	3°	13'	S.
Var. Tab. V. March 12, long. 75° W. sub.		5	
True declination, noon, March 12, long. 75° W.	3	8	S.

The preceding correction ought always to be applied to the declination used in working a meridian observation to determine the latitude, though many mariners are in the habit of neglecting it.

* In finding the declination, or any other quantity, in the Nautical Almanac, you must be careful to note the difference between the civil, nautical, and astronomical account of time. The civil day begins at midnight, and ends the following midnight, the interval being divided into 24 hours, and is reckoned in numeral succession from 1 to 12, then beginning again at 1 and ending at 12. The nautical or sea day begins at noon, 12 hours before the civil day, and ends the following noon; the first 12 hours are marked P. M. the latter A. M. The astronomical day begins at noon, 12 hours after the civil day, and 24 hours after the sea-day, and is divided into 24 hours, numbered in numeral succession from 1 to 24, beginning at noon, and ending the following noon. All the calculations of the Nautical Almanac are adapted to astronomical time; the declination marked in the Nautical Almanac, or in Table IV. is adapted to the beginning of the astronomical day, or to the end of the sea-day, it being at the end of the sea-day when mariners want the declination to determine their latitude. It would be much better if seamen would adopt the astronomical day, and wholly neglect the old method of counting by the sea-day.



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To find the sun's declination at any time under any meridian.

RULE. Reduce the sun's declination at noon at Greenwich to noon under the given meridian, by the preceding rule. Then enter Table V. with the time from noon at the top, and the day of the month in the side column; under the former, and opposite the latter, will be the correction to be applied to that reduced declination. To know whether this correction be additive or subtractive, you must look at the top of the column where you found the day of the month, and you will find it noted whether to add or subtract, according as the time is before or after noon.

EXAMPLE III.

Required the sun's declination October 10, 1824, sea account, at 8h. 21′ in the forenoon, in the longitude of 114° E. from Greenwich?

Sun's declination Oct. 10, at Greenwich at noon, by Tab. IV.		6° 44′ S.
Variation for 114° E. long.	sub.	7
Declination at noon, October 10, in long. 114° E.		6 37 S.
Variation of dec. for 3h. 39′ from noon* Oct. 10,	sub.	3
True dec. Oct. 10, sea acc. in long. 97° E. at 8h. 21′ A. M.		6 34 S.

EXAMPLE IV.

Required the sun's declination May 10, 1824, sea account, at 5h. 30′ P. M. in the longitude of 17° 30′ E. from Greenwich?

Variation of declination, May 10, in long. 17° 30′ E.	sub.	48″
Variation of declination for 5h. 30′ P. M. additive		3′ 44
Diff. is additive because the greatest number is so		2 56
May 10, sea account, is May 9, by N. A. at which time sun's declination		17° 25 10
True declination May 10, 5h. 30′ P. M. sea account in long. 17° 30′ E.		17 28 6 N.

EXAMPLE V.

Required the sun's declination March 26, 1824, sea account, at 3h. P. M. in the longitude of 120° E. from Greenwich?

Variation of declination, March 26, in long. 120° E.	sub.	7′ 50″
Variation for 3h. P. M.	add	2 56
Diff. is subtractive because the greatest number is so		0 4 54
March 26, sea acc. is Mar. 25, by N. A. at which time sun's dec.		1 54 41 N.
True declination March 26, 3h. P. M. sea account		1 49 47 N.

VARIATION OF THE COMPASS.

IT was many years after the discovery of the compass, before it was suspected that the magnetic needle did not point accurately to the north pole of the world; but about the middle of the sixteenth century, observations were made in England and France, which fully proved that the needle pointed to the eastward of the true north. This difference is called the *variation of the compass*, and is named *east* when the north point of the compass (or magnetic north) is to the eastward of the true north; but *west* when the north point of the compass is to the westward of the true north. The quantity of the variation may be found by observing with a compass the bearing of any celestial object when in the horizon (or, as it is called, the *magnetic amplitude*) the difference between this and the true amplitude found by calculation, will be the variation. The same may be obtained by observ-

* In the present example, the time is Oct. 10, 8h. 21′. A. M. which evidently wants 3h. 39″ of the end of the sea day Oct 10, for which time the declination is marked in Table IV.

ing the *magnetic azimuth* of any celestial object (that is, its bearing by a compass when elevated above the horizon;) the difference between this and the true azimuth found by calculation will be the variation.

Some years after the discovery of the variation, it was found that it did not remain constant: for the easterly variation observed in England gradually decreased till the needle pointed to the true north, and then increased to the westward, and is now above two points.

As all the courses steered by a compass must be corrected for the variation to obtain the true courses, it is of great importance to the navigator to know how to find the variation at any time; to do this it is necessary to find the magnetic amplitude or azimuth of a celestial object, which may be done as follows:

*To observe an amplitude by an azimuth compass.**

When the centre of the sun is about one of his diameters† above the horizon, turn the compass round in the box, until the centre of the sun is seen through the narrow slit which is in one of the sight vanes, exactly on the thread which bisects the slit in the other;‡ at that instant push the stop which is in the side of the box against the edge of the card, and the degree and parts of a degree which stand against the middle line on the top will be the magnetic amplitude of the sun at that time, which is generally reckoned from the east or west point of the compass.

To observe an azimuth by an azimuth compass.

Turn the compass round in the box until the centre of the sun is seen through the narrow slit which is in one of the sight vanes, exactly on the thread which bisects the slit on the other, or until the shadow of the thread falls directly along the line of the horizontal bar,‡ the card is then to be stopped, and the degree and parts of a degree which stand against the middle line of the stop, will be the magnetic azimuth of the sun at that time, which is generally reckoned from the north in north latitude, and from the south in south latitude.§ At the time of making this observation, you must also observe the altitude of the sun, in order to obtain the true azimuth.

What is here said of the sun, is alike applicable to the moon, planets, and stars.

TO FIND THE TRUE AMPLITUDE.

RULE.

BY LOGARITHMS.—*To the log-secant of the latitude (rejecting* 10 *in the index) add the log. sine of the sun's declination*:‖ *the sum will be the log. sine of the true amplitude or distance of the sun from the east or west point, towards the north in north declination, but towards the south in south declination.*

BY INSPECTION.—*Find the declination at the top of Table VII. and the latitude in the side column; under the former, and opposite the latter, will be the true amplitude.* When great accuracy is required, you may proportion for the minutes of latitude and declination.

* The figure of an azimuth compass, furnished with sight vanes, is given in Plate VI. fig. 5. The card of this compass is similar to that of a common compass.

† The observation is to be taken at that altitude on account of the dip, refraction and parallax, the correction of altitude depending on these causes being in general nearly equal to the sun's diameter.

‡ If the instrument is furnished with a magnifying glass fixed to one of the vanes, you may (instead of proceeding as above) turn the compass-box until the vane is directed towards the sun, and when the bright speck (or rays of the sun collected by the magnifying glass) falls upon the slit of the other vane, or upon the line in the horizontal bar, the card is to be stopped, and the divisions read off as above.

§ If the compass vibrate considerably at the time of making the observations, it would be conducive to accuracy to take several azimuths and altitudes, and to take the mean of all the azimuths and all the altitudes, and work the observation with the mean azimuth and altitude. The same is to be observed in taking an amplitude.

‖ The declination of the sun at noon is given in the Nautical Almanac, and in Table IV. and must be corrected for the longitude of the ship and the hour of the day, by means of Table V.

EXAMPLE I.

Required the sun's true amplitude at rising, in the latitude of 39° 0′ N. on the 22d of December, 1820?

BY LOGARITHMS.

Latitude	39°	0′	log. sec.	0.10950
Sun's declin. ...	23	28	log. sine	9.60012
True ampli.	30	49	log. sine	9.70962

BY INSPECTION.

Under the declination 23° 28′ and opposite the latitude 39° stands the true amplitude 30° 49′.

Hence the true bearing or amplitude of the sun at rising is E. 30° 49′ S. and at setting it is W. 30° 49′ S.

EXAMPLE II.

Required the moon's true amplitude at setting, in the latitude of 35° 8′ N. when her declination is 13° N.?

BY LOGARITHMS.

Latitude	35°	8′	log. sec.	0.08734
Moon's declin.	13	0	log. sine	9.35209
True ampli. ...	15	58	log. sine	9.43943

BY INSPECTION.

Under the declination 13°, and opposite the latitude 35° stands 15° 56′, which is nearly the true amplitude; the exact value may be found by finding the amplitude for 36° latitude, and proportioning the difference for the miles in the latitude.

Hence the true amplitude at setting is W. 15° 58′ North, and at rising E. 15° 58′ N.

EXAMPLE III.

Required the sun's true amplitude in the latitude of 42° 30′ N. when his declination was 20° N.?

BY LOGARITHMS.

Latitude	42°	30′	log. sec.	0.13237
Sun's declin. ...	20	N.	log. sine	9.53405
True ampli.	27	38	log. sine	9.66642

BY INSPECTION.

Under the declination 20° and opposite the latitudes 42° and 43°, stand 27° 24′ and 27° 53′; the mean of these gives the true amplitude for the latitude of 42° 30′ =27° 38′.

Hence the amplitude at setting is W. 27° 38′ N. and at rising E. 27° 38′ North.

To find the true azimuth at any time.

At the time of observing the magnetic azimuth, you must also observe the altitude of the object; this altitude must be corrected as usual for the dip, parallax, refraction,* &c. in order to obtain the true altitude; you must also find the declination of the object,† and the latitude of the place of observation, and then the true azimuth may be calculated by the following

RULE. Add together the polar distance,‡ the latitude, and the true altitude, take the difference between the half sum and the polar distance, and note the remainder. Then add together the log. secant of the latitude, the log. secant of the altitude (rejecting 10 in each index) the log. co-sine of the half sum, and the log. co-sine of the remainder; half the sum of these four logarithms will be the log. co-sine of half the true azimuth, which being doubled will give the true azimuth, reckoned from the north in north latitude, but from the south in south latitude.

* In observations of the altitude of the sun's lower limb (by a fore-observation) it is usual to add 12′ for the effect of dip, parallax, and semi-diameter. The refraction is to be subtracted from the sum, and the remainder will be the true altitude nearly.

† The declination is to be found according to the directions in the note, in the last page.

‡ The polar distance of the sun, moon, or star, is the distance from the elevated pole, and is found by subtracting the declination of the object from 90°, when the latitude and declination are of the same name, but by adding to 90° when of different names.

EXAMPLE I.

In latitude 51° 32′ N. the sun's true altitude was found to be 39° 28′, his declination being then 16° 38′ N.—required the true azimuth?

Polar distance.........	73°	22′		
Latitude	51	32	secant	0.20617
Altitude..............	39	28	secant	0.11239
Sum	164	22		
Half sum.............	82	11	co-sine	9.13355
Polar distance.........	73	22		
Remainder	8	49	co-sine	9.99484
				2)19.44695
Half sum log. co-sine	58°	4′		9.72347
		2		
True Azimuth	116	8	from the north.	

The logarithm 9.72347 of this example is also the co-sine of 121° 56′, which doubled gives another azimuth 243° 52′, the former being 116° 8′. One of these corresponds to an observation in the forenoon, the other to an afternoon observation.

EXAMPLE II.

In latitude 42° 16′ S. the sun's true altitude was found to be 18° 40′, his declination being then 7° 38′ N.—required the true azimuth?

Polar distance.........	97°	38′		
Latitude	42	16	secant	0.13076
Altitude..............	18	40	secant	0.02347
Sum..................	158	34		
Half sum	79	17	co-sine	9.26940
Polar distance	97	38		
Remainder	18	21	co-sine	9.97734
			sum	19.40097
Half sum log. co-sine ..	59	53		9.70048
		2		
True Azimuth	119	46	from the south.	

QUESTIONS TO EXERCISE THE LEARNER.

Question I. Given the sun's altitude corrected for dip, refraction, &c. 20° 46′, his declination 17° 10′ S. and the latitude of the place 40° 38′ N. Required the true azimuth?

Answer. 137° 50′ from the north.

Question II. What is the sun's azimuth in the latitude of 26° 30′ N. in the forenoon, when his correct central altitude is 24° 28′ and his declination 22° 40′ N.?

Answer. 75° 44′ from the north.

Question III. At the Island of St. Helena the sun's true central altitude was found to be 30° [illegible] in the forenoon, his declination being then 22° 58′ S. Required the azimuth at that time?

Answer. 72° 21′ from the south.

Question IV. What point of the compass did the star Aldebaran bear on, in the latitude of 34° 23′ S. on January 1, 1804, when the correct altitude of that star was 22° 26′?

Answer. 130° 16′ from the south.

Having the true magnetic amplitude or azimuth, to find the variation.

Having found the true and magnetic amplitude or azimuth, the variation may be easily deduced therefrom by the following rule, in which the amplitude is reckoned from the east or west point of the horizon, and is called north when to the northward of those points, but south when to the south-

ward. The azimuth is reckoned from the north in north latitudes, but from the south in south latitudes, and is named east when falling on the east side of the meridian, otherwise west. *If the observed and true amplitudes be both north or both south, their difference will be the variation; but if one be north and the other south, their sum will be the variation. If the true and observed azimuths be both east or both west, their difference will be the variation, otherwise their sum; and the variation will be easterly when the point representing the true bearing is to the right hand of the point representing the magnetic bearing, but westerly when to the left hand; the observer being supposed to look directly towards the point representing the magnetic bearing.*

EXAMPLE I.

Suppose the sun's magnetic amplitude at rising is E. 26° 12′ N. and the true amplitude E. 14° 20′ N. Required the variation?

From the greater	E. 26°	12′	N.
Take the lesser	E. 14	20	N.
Remains variation	11	52	E.

The variation in this example is easterly, because the true amplitude falls to the right of the magnetic.

EXAMPLE II.

The moon's true amplitude at rising was found to be E. 15° 20′ N. and her magnetic amplitude E. 10° 0′ S. Required the variation?

True amplitude........E.	15°	20′	N.
Magnetic amplitude ....E.	10	0	S.
The sum is the variation ...	25	20	W.

EXAMPLE III.

The sun's true azimuth being N. 80° E. and his magnetic azimuth N. 60° E. it is required to find the variation?

True azimuth ....N.	80°	E.
Magnetic azimuth ....N.	60	E.
Diff. is the variation............	20	E.

EXAMPLE IV.

The star Aldebaran was observed at rising to bear by compass E. N. E. when the true amplitude was N. E. by E.—Required the variation?

True amp. N. E. by E. or E.	33°	45′	N.
Mag. amp. E. N. E. or E.	22	30	N.
Difference is the variation ..	11	15	W.

EXAMPLE V.

The true amplitude of the planet Jupiter was E. 10° N. when his magnetic amplitude was E. 20° S.—Required the variation?

True amplitude.............E.	10°	N.
Magnetic amplitude ....E.	20	S.
Sum is variation................	30	W.

To calculate the variation by observing the sun's azimuth when at equal altitudes in the forenoon and afternoon.

The variation of the compass may also be determined by observing the magnetic azimuths of the sun in the morning and evening when at the same altitude, the observer being supposed to be at the same place at both observations; for it is evident that if the declination of the sun did not vary during the time elapsed between the observations, the middle point of the compass between the two bearings would be the bearing of the true north or south point of the horizon, at the place of observation, and the difference between that bearing and the north or south point of the compass would be the variation.

In this kind of observations it will be convenient always to estimate the magnetic azimuths from the south point of the compass, calling them east or west, as before directed, and this method is supposed to be made use of in the following rule. Then, if one azimuth be east and the other west, half their difference will be the variation, otherwise their half sum, and the variation will be of the same name as their greater azimuth, excepting, however, where the half sum is taken and exceeds 90°, in which case its supplement will be the variation of a different name from the azimuth. The variation being always supposed less than 90°.

If the declination of the sun varies during the elapsed time between the observations, (as is generally the case) an allowance may be made for that variation by applying a correction to the afternoon azimuth, calculated by the following rule.*

* The rule given in Doctor Mackay's "Complete Navigator" is inaccurate.

RULE. Find from Table IV. the daily variation of the sun's declination on the day of observation. Then *to the constant logarithm 9.1249 add the log. co-sine of the latitude of the place, the log. sine corresponding to the elapsed time between the observations found in the column P. M. the Prop. Log. of the daily variation of the sun's declination, and the Prop. Log. of the elapsed time*, estimating hours and minutes as minutes and seconds, the sum, rejecting 30 in the index, will be the Prop. Log. of the correction to be applied to the western azimuth, by subtracting when the sun is approaching towards the northern hemisphere, otherwise by adding.*† The azimuth thus corrected is to be used in estimating the variation instead of the observed azimuth.

It is not necessary in this calculation to find the latitude or declination to any great degree of accuracy, which is the greatest advantage of the method; another of the advantages consists in being able to take a great number of observations, and applying the correction at one operation to the variation deduced from the mean of all the observations, so that, when great accuracy is required, as in taking observations ashore, this method may be used with success; and it is evident that it is alike applicable to the moon or any heavenly body, but the observations must be taken in the same place, as it would increase the calculation considerably, to make an allowance for the change of place, as well for the change of declination; and it would be better in this case to calculate each observation separately by the rules before given.

EXAMPLE.

Suppose that on the 10th of April, 1820, in the latitude of 42° 29′ N. long. 50° W. the sun's morning azimuth was observed to be S. 54° 24′ E. and in the evening, when the sun was at the same altitude, was S. 39° 46′ W. the elapsed time between the observations being 6h. 20m.—Required the variation?

Constant logarithm	9.1249
Latitude 42° 29′ co-sine	9.8677
Elapsed time 6h. 20m. Sine	9.8676
Daily variation of declination 22′ P. L.	.9128
Elapsed time 6h. 20m. taken as 6′ 20″ P. L.	1.4536
Corr. western azimuth 11′ nearly P. L.	1,2266
Western azimuth S. 39 46 W.	
Corrected azimuth S. 39 35 W.	
Morning azimuth S. 54 24 E.	
Difference 14 49	

The half of which 7° 24′ is the variation, which is easterly, because the greater azimuth S. 54° 24′ E. is easterly.

The variation, thus found, is to be allowed on all courses steered by the compass to obtain the true courses. To make this allowance, you must look towards the point of the compass the ship is sailing upon, and allow the variation from it *towards the right hand, if the variation be east, but to the left hand, if the variation be west.* Thus, if a ship steer S. E. with one point westerly variation, the true course will be S. E. by E. If the variation is one point easterly, the course will be S. E. by S.

In the following Table are collected a few observations of the variation, made at different times, and in different places.

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* The elapsed time may be determined by any common watch, but if none was used in the observations, it may be determined as follows. If one of the observed azimuths was east and the other west, take half their sum, otherwise half their difference, and to the log. sine of this half sum (or half difference) add the log. secant of the sun's declination, and the log. co-sine of the sun's correct altitude at the time of taking the azimuth, the sum (rejecting 20 in the index) will be the log. sine to be used in the above calculation, and this logarithm will correspond to the elapsed time, marked in the column P. M. of Table XXVII.

† In this rule it is supposed that the bearing of the sun, by the afternoon observation, is to the westward of the meridian by compass; but if there be a great variation, that bearing might be to the eastward of the meridian by the compass, and in that case the correction of the western azimuth must be applied in a contrary manner to the above directions.

Places observed at.	Latitude.	Longitude from Greenwich.	Year of Observation.	Variation Observed.
Cambridge, (Mass.)	42° 23′ N.	71° 8′ W.	1708	9° 0′ W.
			1742	8 0 W.
			1757	7 20 W.
			1761	7 14 W.
			1763	7 0 W.
			1782	6 46 W.
Boston.	42 23 N.	71 4 W.	1742	8 0 W.
Beverly (town.)	42 36 N.	70 52 W.	1781	7 2 W.
Salem.	42 33 N.	70 52 W.	1805	5 57 W.
			1808	5 20 W.
London.	51 31 N.	0 5 W.	1580	11 15 E.
			1672	2 30 W.
			1780	22 41 W.
Paris.	48 50 N.	2 20 E.	1550	8 0 E.
			1660	0 0
			1769	20 0 W.
Funchal Road.	32 38 N.	17 5 W.	1792	18 35 W.
St. Croix Road.	28 27 N.	16 16 W.	1792	17 35 W.
Bonavista.	16 6 N.	22 58 W.	1792	12 36 W.
St. Jago (Praya Bay.)	14 52 N.	23 30 W.	1769	11 10 W.
			1792	12 48 W.
Isle of May.	15 4 N.	22 46 W.	1792	12 00 W.
Ascension.	7 56 S.	14 21 W.	1678	1 0 E.
			1776	10 45 W.
St. Helena.	15 55 S.	5 51 W.	1677	0 40 E.
			1776	13 15 W.
			1794	16 16 W.
Tristan d'Acunha.	37 7 S.	11 38 W.	1792	7 0 W.
Cape of Good Hope.	34 26 S.	18 23 E.	1776	21 0 W.
Cape Lagullas.	34 53 S.	20 10 E.	1600	0 0
			1692	11 0 W.
			1776	21 40 W.
			1790	23 30 W.
Island St. Paul.	37 56 S.	77 28 E.	1677	23 30 W.
			1803	19 30 W.
Isle of Bourbon.	20 52 S.	55 31 E.	1795	15 33 W.
Java Head.	6 46 S.	104 50 E.	1676	3 10 W.
			1786	0 54 W.
Batavia.	6 10 S.	106 51 E.	1793	0 30 W.
At Sea.	29 10 N.	28 52 W.	1795	15 00 W.
At Sea.	27 00 N.	23 43 W.	1795	15 44 W.
At Sea.	15 28 N.	20 48 W.	1795	12 5 W.
At Sea.	12 14 N.	20 5 W.	1795	11 39 W.
At Sea.	9 47 N.	20 15 W.	1795	11 48 W.
At Sea.	8 54 N.	20 15 W.	1795	10 50 W.
At Sea.	5 46 N.	20 54 W.	1795	11 00 W.
At Sea.	3 16 N.	21 27 W.	1795	10 47 W.
At Sea.	0 0	24 20 W.	1795	8 43 W.
At Sea.	2 33 S.	24 54 W.	1795	7 5 W.
At Sea.	5 48 S.	26 54 W.	1795	5 24 W.
At Sea.	7 59 S.	27 54 W.	1795	4 14 W.
At Sea.	9 27 S.	27 55 W.	1795	3 33 W.
At Sea.	13 19 S.	26 58 W.	1795	3 54 W.
At Sea.	19 47 S.	25 56 W.	1795	2 50 W.
At Sea, near Trinidad.	20 28 S.	28 44 W.	1796	2 35 W.
At Sea.	21 32 S.	25 27 W.	1795	2 25 W.
At Sea.	23 43 S.	23 45 W.	1795	2 31 W.
At Sea.	28 11 S.	18 45 W.	1795	5 28 W.
At Sea.	35 5 S.	6 0 W.	1795	11 10 W.
At Sea.	36 38 S.	0 15 E.	1795	13 40 W.
At Sea.	36 12 S.	4 16 E.	1795	15 19 W.
At Sea.	37 20 S.	7 25 E.	1795	16 57 W.
At Sea.	36 45 S.	19 27 E.	1795	24 33 W.
At Sea.	21 54 S.	53 41 E.	1795	13 59 W.
At Sea.	0 0	32 35 W.	1795	3 0 W.

By the preceding table it appears that the variation at Cambridge, in the state of Massachusetts, is decreasing at the rate of about 1¾ minutes per year, and by late observations at Salem, the needle there appears to be still approaching towards the true meridian. At London and Paris the variation formerly increased 10 or 11 minutes per year, but by some late observations made in London, it appears to be nearly stationary. Off the Cape of Good Hope the annual increase is about 7 minutes.

Besides this annual change of the variation, there is also a small *diurnal* change, which at London, Paris and Cambridge (Mass.) is from 10′ to 15′. By this quantity the absolute variation at those places increases from about 8 A. M. to 2 P. M. when the needle becomes stationary for some time; after that, the variation decreases, and the needle comes back again to its former situation, or nearly so, in the night or by the next morning.

In addition to the observations contained in the preceding table, it may be observed, that the variation which (at present) is less than ¾ point W. near Cape Cod, decreases in going to the westward along the coast of the United States of America, so that near Cape Hatteras it is scarcely sensible, and farther to the westward becomes easterly. In the leeward West India islands it is about ½ point E. and in the windward islands ¼ point E. Along the northern shore of the Brazils there is a small easterly variation which decreases in proceeding to the eastward towards Cape Roque, where it is scarcely sensible; in proceeding farther to the southward along the coast of America, the easterly variation increases so as to be above 2 points E. near Cape Horn, and from thence gradually decreases along the coast of Chili and Peru, so as to be about ¾ point E. under the equator near Quito; but in proceeding to the northward toward the N. W. coast of America, the easterly variation increases to more than 2 points.

On the contrary in proceeding to the eastward of the United States of America, the westerly variation increases, being nearly 1 point W. a little to the eastward of Cape Sable (Nova Scotia) and about 2 points W. on the E. part of Newfoundland, and at the Western Islands. At the Orkney islands it is 2½ points westerly and is nearly the same in the English Channel, and on the coasts of England, Scotland and Ireland. On the coast of Holland, it is from 2 to 2¼ points W. In the Cattegat and Sound about 1¾ points W. In the Western part of the Baltic about 1½ points. At the entrance of the Gulf of Finland 1 point W. In the Bay of Biscay about 2¼ points W. Near Cape St. Vincents 2 points W. In the Mediterranean from 1¼ to 1¾ points W. Near Cape Verd (Africa) 1¼ points W. and from thence gradually increases along the western shore of Africa towards the Cape of Good Hope, and is there above 2 points W. and from thence increases towards Cape Lagullas and a little to the eastward to 2½ points or 2¾ points W. and then decreases in proceeding along the eastern shore of Africa, and is about 1 point westerly at the entrance of the Red Sea. In the Arabian Sea, Bay of Bengal, Java Sea, China Sea, and off the coast of Sumatra, it is very small, and on the S. E. part of New Holland is about ½ point E.

Ships sailing for India generally cross the equator between the longitudes of 18° and 24° west. The variation at the latter place was about 8° 48′ W. in the year 1795, as I have found by repeated observations, and the annual increase is about 6 minutes. If, in crossing the equator, you should find a greater variation, you would probably be to the eastward of 24° W. but if less, to the westward of 24° W. The alteration in the longitude is in that place about 2 degrees for 1 degree of variation. But there is always a great uncertainty attending this kind of observations, made with a common compass, since it is not uncommon to find 2 or 3 degrees difference between an azimuth in the morning and evening, when the ship during that time has been nearly stationary; the same difference will sometimes be found merely from making the observation when the ship is on a different tack. This is owing to the iron in the ship which attracts the compass by a force which is generally situated in a point near the centre of the ship. When this point and

the compass are in the magnetic meridian of the compass, the true variation is obtained, but as soon as the position of the ship is changed so as to bring this point to the eastward or westward of the magnetic meridian passing through the compass, a corresponding change or observation in the variation to the eastward or westward is immediately perceived. This deviation sometimes amounted to 8° or 9° in the surveys of New Holland. This has since been confirmed by various observations in different places, particularly in the voyages towards the north pole lately made by order of the English government. The method which was at first used to correct this error, which is sometimes of considerable importance in nautical surveys, where great accuracy is required, was to *place the compass always in the same part of the ship*, and to find by actual observation, the greatest deviation arising from this local attraction, which is when the ship's head is directed east or west. The deviation when the ship's head is in any other direction, is found by entering Table I. or Table II. in the page corresponding to that direction as a course, and with that greatest error in minutes in the distance column, the corresponding number in the departure column will be the required correction nearly. Thus if the deviation was 2° 8′ or 128′ when the ship's head was directed towards the east, the deviation when in the direction of *one* point from the meridian, (that is N. by E. N. by W. S. by E. or S. by W.) would be found by entering Table I. in the page for one point, or with the distance 128′, the corresponding departure 25′ would be the correction to be applied on all bearings taken by the compass when in that situation. Mr. Barlow has invented a method of correcting this error, making use of a curious property of the attractive force of iron on the compass, it having been found that this force depends on the *attractive surface*, and not wholly on the quantity of iron; so that a *solid globe* of iron 30 inches in diameter, would affect the compass exactly in the same manner as a *hollow shell* of iron of the same diameter made of sheet iron only one tenth of an inch in thickness, though this shell could not contain but *one hundredth part* the quantity of iron which the globe does. Mr. Barlow therefore proposed to have a sheet of iron placed abaft the compass of such dimensions, and at such a distance, as should be found by experiment to bring the needle back to the magnetic meridian when the ship's head was east or west, then keeping the iron in that position it could correct the error of the local attraction of the ship in every direction of the ship's head. This method has been tested by experiment and found to succeed admirably. It has also been attended with the great advantage of leaving the compass free to act by the natural magnetism of the earth in high latitudes, where the force is much enfeebled by the obliquity of its direction on account of the greatness of the *dip*. In the voyages above named it was found that the compasses thus furnished traversed freely and accurately, when those of the common form moved very irregular, and were in some cases almost useless.

On the Dip of the Magnetic Needle.

If the needle of a compass be exactly balanced on its point in a horizontal position, and then the magnetic virtue be communicated, the needle will point towards the north, and will also be inclined to the horizon, the north point of the needle tending downwards, and the south point upwards in northern climates, and the contrary in southern climates. This inclination of the needle to the horizon is called *The Dip of the Magnetic Needle*, which is different in different places, though it has been found to remain nearly the same in the same place, since its discovery in the year 1576, in which year at London the dip was 71° 50′, in 1723 it was 74° or 75°, and at present is about 72½°. Messrs. Humbolt and Biot published a method by which the dip may be calculated for any given place in north latitudes to a considerable degree of accuracy. This method is explained in the 22d vol. of Tilloch's Magazine, and is in substance as follows:

According to their theory there are *two magnetic poles*, one in the latitude of 79° 1′ N. and in the longitude of 27° 42′ W.* from Greenwich, the other diametrically opposite, in the latitude of 79° 1′ S. and in the longitude of

* Capt. Parry, in his voyage to the north, found the northern pole to be nearly in 70° N. and 90° W.

152° 18′ E. The great circle of the earth 90° distant from these poles is called the *magnetic equator*. On the magnetic equator the dip is nothing, and at the poles is 90°, at any other point on the surface of the earth the dip varies with the distance from the magnetic pole: This distance may be calculated by common spherical trigonometry, or, (which is much more simple and sufficiently accurate for this purpose) by measuring the distance on a terrestrial globe from the magnetic pole to the place for which the dip is to be calculated; then to the log. co-tangent of this distance add the constant logarithm 0.30103, the sum will be the log. tangent of the dip. The dip was calculated on these principles for twenty-eight places in Europe, Asia, Africa and America, and in ten places the theory did not differ 1° from actual observations, and in five places did not differ 2°, but at Spitzbergen the difference was between 4° and 5°. Considering the difficulty of observing the dip with accuracy, the difference between the theory and observation may be considered as nearly within the limits of the errors of observation, and this difference may be rendered less by introducing a small correction depending on the longitude of the place of observation referred to the magnetic equator.

The methods proposed for finding the longitude by the variation and by the dip, will be hereafter explained.

TO FIND THE LATITUDE BY OBSERVATION.

THE latitude of a place being its distance from the equator, is measured by an arch of the meridian contained between the zenith and the equator; hence, if the distance of any heavenly body from the zenith when on the meridian, and the declination of the object be given, the latitude may be thence found.

The meridian zenith distance of any object may be found by observing its altitude when on the meridian, or by observing one altitude taken at a given hour from passing the meridian, or by two altitudes taken out of the meridian and the elapsed time between the observations—each of these methods will be explained by proper examples.

Altitudes of the sun and moon taken at sea require four corrections in order to obtain the true altitude of their centres; these are for Semi-diameter, Dip, Refraction, and Parallax.* When a planet or star is observed, the corrections for dip and refraction only are to be applied, as the semi-diameter and parallax of a planet are but a few seconds, and may be neglected in finding the latitude at sea.

In a fore-observation with a quadrant, sextant or circle, the semi-diameter is to be added if the lower limb was observed, but subtracted if the upper limb was observed. The dip and refraction are to be subtracted and the parallax to be added, and the central altitude will be thus obtained, which being subtracted from 90° will give the true zenith distance.

In a back-observation with a quadrant, the semi-diameter is to be subtracted if the lower limb was observed, but added if the upper limb was observed. The dip and parallax are to be added, and the refraction subtracted, and the central altitude will be obtained, which being subtracted from 90° will give the true zenith distance.

In a back-observation with a sextant or circle, by measuring the supplement of the altitude by bringing the lower limb of the image of the object to touch the back horizon, the semi-diameter and refraction must be added to

* The semi-diameter of the sun may be found in the 3d page of the month of the Nautical Almanac and is nearly 16′. The sun's parallax is to be found in Table XIV. The refraction in Table XII. The dip in Table XIII. The semi-diameter and parallax of the moon may be found from the Nautical Almanac, as will be explained hereafter. It may also be observed, that it is usual to add 12′ for the correction for semi-diameter, dip and parallax, in a fore-observation of the sun's lower limb, taken on the deck of a common sized vessel, and by subtracting the refraction from the sum, the true altitude will be obtained nearly, and it ought always to be kept in mind that the refraction at low altitudes is of too much importance to be neglected.

the altitude given by the instrument, and the dip and parallax subtracted therefrom, and by subtracting 90° from the remainder, the true zenith distance will be obtained.

To find the Latitude by the meridian altitude of any object.

Having obtained the true meridian zenith distance by either of these methods, you must then find the declination of the object at the time of observation. This may be found for the sun by the Nautical Almanac or by means of Tables IV. and V. in the manner before explained. The declination of a fixed star may be easily found by inspection in Table VIII. The declination of the moon or a planet may be found in the Nautical Almanac in a manner which will be hereafter explained. Having the meridian zenith distance and declination, the latitude is to be found by the following rules.

CASE I.

When the object rises and sets.

Rule. If the object bear *south*, when upon the meridian, call the zenith distance *north*;* but if the bearing be north you must call the zenith distance *south*. Place the zenith distance under the declination, and if they are of the same name add them together, but if they are of different names, take their difference; this sum or difference will be the latitude which will be of the same name as the greatest number.

CASE II.

When the object does not set, but comes to the meridian above the horizon twice in 24 hours.

Many stars are always above the horizon of certain places of the earth, and in high latitudes the sun is sometimes above the horizon for several days, in which case the meridian altitude may be observed twice in 24 hours; that is, once at the greatest height above the pole, and again at the lowest height upon the meridian below the pole. In the former case, the latitude is to be found by the preceding rule, but in the latter, by the following

Rule. Add the complement of the declination to the meridian altitude; the sum will be the latitude, of the same name as the declination.

Note. When the sun or star is on the equator, or has no declination, the zenith distance will be equal to the latitude of the place, which will be of the same name as the zenith distance.

When the sun or star is in the zenith, the declination will be equal to the latitude, and it will be of the same name as the declination.

To find the latitude by the meridian altitude of the sun or star.

EXAMPLE I.

Suppose that at the end of the sea day, June 21, 1824, in the longitude of 60° W. the meridian altitude of the sun's lower limb bearing south, was found by a fore-observation to be 40° 6′—required the latitude, supposing the correction of the observed altitude for parallax, dip, and semi-diameter to be 12 miles?

Observed altitude..............	40°	6′
Par. dip, and semi-diam. add		12
Sum	40	18
Refraction..........subtract		1
True altitude.................	40	17
Subtract from	90	00
True zenith distance	49	43 N.
Sun's declination, Tab. IV......	23	28 N.
Latitude	73	11 N.

EXAMPLE II.

Suppose that at the end of the sea day, April 14, 1824, in the longitude of 140° E. from Greenwich, the altitude of the sun's lower limb by a fore-observation was 60° 25′ when on the meridian and bearing south, the correction for dip, semi-diameter and parallax being 12 miles—required the latitude?

Observed altitude.............	60°	25′
Correction...............add		12
True altitude†	60	37
Subtract from	90	0
True zenith distance	29	23 N.
Sun's declination, Tab. IV. cor. by Tab. V. for long.	9	21 N.
Latitude	38	44 N.

* In this rule the sun is supposed to be the fixed point, and the zenith is referred to it. Thus, if the sun bears south from an observer (or from his zenith) the zenith bears north from the sun, and it is this latter bearing which is used in the rule.

† The refraction being small is here neglected.

EXAMPLE III.

Suppose that at the end of the sea day, May 15, 1824, in the meridian of Greenwich, the meridian altitude of the sun's lower limb bearing north was found by a fore-observation to be 30° 6′, the correction for parallax, dip and semi-diam. being 12 miles—required the latitude?

Observed altitude...............	30°	6′	
Par. dip, and semi-diam....add		12	
Sum	30	18	
Refraction ....subtract		2	
True altitude	30	16	
Subtract from.................	90	00	
True zenith distance	59	44	S.
Sun's declination	18	55	N.
Latitude......................	40	49	S.

EXAMPLE IV.

Suppose that at the end of the sea day, Nov. 17, 1824, in the longitude of 80° E. from Greenwich, by a fore-observation the meridian altitude of the sun's lower limb was 50° 6′, bearing south; the eye of the observer being 17 feet above the surface of the sea—required the latitude?

Observed altitude..............	50°	6′	
Sun's semi-diam. ....add		16	
	50	22	
Subtract dip and refraction......		5	
True altitude*	50	17	
Subtract from..................	90	0	
True zenith distance...........	39	43	N.
Sun's dec. cor. by Tab. V.......	19	1	S.
Latitude	20	42	N.

EXAMPLE V.

By a fore-observation, the meridian altitude of the sun's lower limb was found to be 40° 20′ bearing south of the observer, the declination being 9° 56′ N. and the eye 26 feet above the horizon—required the latitude of the place?

Observed altitude	40°	20′	
Semi-diameter ....add		16	
	40	36	
Dip 5′, refraction 1′,.....sub.		6	
True altitude sun's centre*.....	40	30	
Subtract from................	90	00	
Zenith distance................	49	30	N.
Declination	9	56	N.
Latitude.....................	59	26	N.

EXAMPLE VI.

By a back-observation with a quadrant of reflection, the meridian altitude of the sun's lower limb was 25° 12′ when the declination was 21° 14′ S. and the eye of the observer 40 feet above the horizon, the sun bearing S.—required the lat. of the place of observation?

Observed altitude	25°	12′	
Semi-diameter..........sub.		16	
	24	56	
Dip ....add		6	
	25	2	
Refraction ....sub.		2	
True alt. of sun's centre*......	25	0	
True zenith distance	65	0	N.
Declination	21	14	S.
Latitude	43	46	N.

EXAMPLE VII.

Suppose that on January 1, 1824, an observer 17 feet above the water finds by a fore-observation that the altitude of Sirius is 53° 33′ when passing the meridian to the southward; required the latitude of the place of observation?

Observed altitude	53°	33′	
Dip of horizon ....sub.		4	
	53	29	
Refraction ....sub.		1	
	53	28	
True zenith distance	36	32	N.
Sirius' declin. Tab. VIII.†......	16	29	S.
Latitude	20	3	N.

EXAMPLE VIII.

Suppose that on the 13th June, 1824, sea account, an observer in a high northern latitude and in the longitude of 65° W. from Greenwich, his eye being 20 feet above the surface of the water, observed by a fore-observation the altitude of the sun's lower limb on the meridian below the pole 8° 14′: required the latitude?

The sun being below the pole at 12 hours before the end of the sea day June 13, the correction of declination corresponding in Table V. is—1′ 46″, and the correction for 65° W. long. is+0′ 38″, hence both corrections make nearly 1′ to be subtracted from the declination at noon 23° 14′ N. which will give the declination at the time of observation 23° 13′ N. the comp. of which is 66° 47′.

Observed alt. sun's lower limb	8°	14′	
Semi-diameter ....add		16	
	8	30	
Dip...................sub.		4	
	8	26	
Refraction ....sub.		6	
True alt. of sun's centre‡......	8	20	
Complement of declination	66	47	N.
Latitude.....................	75	7	N.

* The parallax being small is here neglected, and the sun's semi-diameter is supposed to be 16′.

† The north polar distances of these bright stars are given for every 10 days in the Nautical Almanac; when great accuracy is required, the declinations deduced from these may be used instead of the numbers in Table VIII.

‡ The parallax being small is neglected.

EXAMPLE IX.

Suppose that on January 10, 1824, an observer 18 feet above the water, finds the altitude of the north star, when on the meridian below the pole, to be 36° 23′ by a fore-observation; required the latitude of the place of observation?

Observed altitude	36° 23′	
Subtract dip. 4′. ref. 1′........	5	
True altitude	36 18	
Comp. declin. Tab. VIII.*	1 38	N.
Latitude....................	37 56	N.

EXAMPLE X.

Suppose that by a back-observation with a sextant the lower limb of the sun's image was brought to the back horizon, and the angle shown by the index was 110° 10′, the sun being then on the meridian and bearing south, the declination being 20° 5′ N. the sun's semi-diameter 16′ and the observer 20 feet above the horizon; required the latitude?

Observed angle	110° 10′	
Semi-diameter........add	16	
	110 26	
Dip ....sub.	4	
	110 22	
Subtract.................	90 0	
Zenith distance†	20 22	N.
Declination	20 5	N.
Latitude..................	40 27	N.

EXAMPLE XI.

Suppose that by a back-observation with a sextant the lower limb of the sun's image was brought to the back horizon, and the angle shown by the index was 106° 12′, the altitude of the observer being 22 feet and the correction for semi-diameter, parallax, and dip being (as usual) about 12′; required the true latitude, supposing the declination to be 20° S. and that the sun bore north at the time of observation?

Observed angle...........	106° 12′	
Dip and semi-diam.....add	12	
	106 24	
Subtract	90 0	
Zenith distance‡..........	16 24	S.
Sun's declination	20 0	S.
Latitude	36 24	S.

It was observed in the directions for finding the meridian altitude of an object, that an error would arise if the ship were in motion, or the sun's declination should vary. The amount of this correction may be estimated in the following manner.

Find the number of miles and tenths of a mile *northing* or *southing* made by the ship in one hour, and also the variation of the sun's declination in an hour expressed also in miles and tenths. Add these together, if they both conspire to elevate or depress the sun, otherwise take their difference, which call the arch A. Find in Table XXXII. the arch B, expressed in seconds, corresponding to the latitude and declination; then the arch A, divided by *twice* the arch B, will express the time in *minutes from noon* when the greatest (or least) altitude was observed. Moreover, the square of the arch A, divided by five times the arch B, will be the number of *seconds* to be applied to the observed altitude to obtain the true altitude which would have been observed if the ship had been at rest.

Thus if the ship sailed towards the sun south 12 miles per hour, the declination increasing northerly 1′ per hour, we should have $A=11+1=12$. If the latitude was 42° N. declination 2° S. we should have by Tab. XXXII. $B=2''$. In this case the time from noon is $\frac{12}{4}=3$ minutes, and the correction of altitude $\frac{144}{8}=18$ seconds only.

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* The north polar distances of these bright stars are given for every 10 days in the Nautical Almanac; when great accuracy is required, the declinations deduced from these may be used instead of the numbers in Table VIII.

† The refraction and parallax being only a few seconds are neglected.

‡ The refraction being small is neglected.

TO FIND THE LATITUDE

BY THE

MERIDIAN ALTITUDE OF THE MOON.

THE latitude may be found at sea by the moon's meridian altitude more accurately than by any other method, except by the meridian altitude of the sun; but to do this it is necessary to find the time of her passing the meridian, and her declination at that time. To facilitate these calculations we have given the Tables XXVIII. XXIX. and XXX. The uses of which will evidently appear from the following rules and examples.

To find the true time of the moon's passing the meridian.

In the sixth page of the Nautical Almanac, find the time of the moon's coming to the meridian of Greenwich for one day earlier than the sea account;* and also the time of her coming to the meridian of Greenwich the next day, when you are in west longitude, but the preceding day when in east longitude; take the difference between these times, with which you must enter the top column of Table XXVIII. and against the ship's longitude in the side column will be a number of minutes to be applied to the time taken from the Nautical Almanac, for the day immediately preceding the sea account, by adding when in west longitude, but subtracting when in east longitude; the sum or difference will be the true time of passing the meridian of the given place.

EXAMPLE.

Required the time of the moon's passing the meridian of Philadelphia, April 19, 1820, sea account?

The day preceding the sea account is April 18, on which day the moon passed the meridian of Greenwich at 5h. 3m.; and being in west longitude, I find also the time of her passing the meridian the next day, 5h. 55m.; the difference of these two numbers is 52m.; with this I enter Table XXVIII. and at the top find 52′; under this and opposite 75° (the longitude of Philadelphia) is the correction 11′, to be added to 5h. 3m.; therefore the time of passing the meridian of Philadelphia is April 19d. 5h. 14m. sea account; or April 18d. 5h. 14m. P. M. civil account.

To find the moon's declination when on the meridian.

Find the time of the moon's coming to the meridian as above; turn the ship's longitude into time, (by Table XXI.†) and add it thereto if in west longitude, but subtract it in east, the sum or difference will be the time at Greenwich.—Take out the moon's declination from page 6th of the Nautical Almanac, for the nearest noon and midnight;‡ and note the difference of the declinations if of the same name, but their sum if of different names; enter Table XXX. with this sum or difference at the top, and the time at Greenwich in the side column, under the former and opposite the latter will be the correction to be applied to the declination which stands first in the

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* Taking the time one day earlier than the sea account reduces it to astronomical time used in the Nautical Almanac.

† Longitude may be turned into time without the help of Table XXI. by multiplying by 4 sexagesimally, and putting the product one denomination lower; and by dividing by 4, time may be turned into degrees, &c. Thus 80° × 4 = 320′ = 5h. 20m. and 15° 16′ × 4 = 61′ 4″ = 1h. 1m. 4s.; in like manner 1h. 20m. or 80m. divided by 4, gives 20°, 3h. 16m. or 196m. divided by 4, gives 49°, which agree with the Table. If the ship be furnished with a chronometer regulated to Greenwich or mean time, this part of the operation will be saved, for by applying the equation of time, Table IV. A., with a *contrary* sign to that in the Table, the *apparent* time at Greenwich will be obtained, as in the explanation prefixed to the Tables.

‡ If the time at Greenwich be exactly noon or midnight, the true declination will be given by the Nautical Almanac, without the trouble of referring to Table XXX.

Nautical Almanac; additive, if that declination be increasing; subtractive, if decreasing; the sum or difference will be the true declination at the time of passing the meridian.

NOTES.

1. By the above rule, the day of the month on which the moon passes the meridian must be taken one less than the sea account: and when you add the longitude (turned into time) to the time of passing the meridian, and the hours of the sum exceed 24, you must subtract 24h. and add one to the day of the month; if the longitude be subtractive and greater than the time of passing the meridian, you must, previous to the subtraction, add 24 hours to the time of passing the meridian, and subtract one from the day of the month; the sum or difference will be the time at Greenwich. If this time be less than 12 hours, you must take out the declination for the preceding noon and the following midnight; but if the time exceed 12 hours, you must take out the declination for the preceding midnight and the following noon.

2. When one of the declinations taken from the Nautical Almanac is north and the other south, the difference between the correction of Table XXX. and that declination which stands first in the Nautical Almanac, will be the true declination, which will be of the same name as that first declination, when the correction of Table XXX. is less than the first declination, but if greater of a contrary name.

3. In the same manner we may find the declination for any time in the day, by making use of the given time instead of the time of the moon's passing the meridian.

4. In the above rules the second differences of the moon's motion are neglected. In cases where very great accuracy is required, the calculation may be made as in Problem I. of the Appendix.

EXAMPLE.

Required the moon's declination at the time of her passing the meridian of Philadelphia, April 19, 1820, sea account?

The time of passing the meridian of Philadelphia was found in the preceding Example to be April 19d. 5h. 14m. sea account, or April 18th. 5h. 14m. by Nautical Almanac account; this being added to the longitude of Philadelphia, in time 5h. 1m. nearly, the sum is the time at Greenwich, April 18th. 10h. 15m. The declination April 18th. at noon, was 28° 26′ N. and on April 18th. at midnight 27° 48′ N. the difference being 38′, this being found at the top of Table XXX. and the time 10h. 15m. in the side column, the number corresponding is 33′, which subtracted from the first declination 28° 26′ leaves the declination required 27° 53′ N.

At the time of the moon's passing the meridian you must observe the altitude of her upper or lower limb, and correct this altitude for semi-diameter, dip, parallax, and refraction, and you will obtain the central altitude, with which and the declination you may find the latitude by the rules before given. Or you may correct the observed altitude by the following approximate method which shortens the calculation, and is sufficiently accurate, especially when the dip is about 4′ or 5′, which is nearly the value in common observations at sea.

To find the latitude by the moon's meridian altitude, obtained by a fore-observation.

To the observed altitude of the moon's lower limb add 12 minutes, but if her upper limb was observed, subtract 20 minutes; with this altitude enter Table XXIX. and take out the minutes corresponding and add thereto, the sum will be the central altitude of the moon;* with this altitude and the moon's declination found as above, the latitude may be found as by a meridian altitude of the sun.

* In calculating accurately the moon's central altitude, you must proceed in the following manner: Find the time of the moon's passing the meridian reduced to Greenwich time as above, take out the moon's horizontal parallax and semi-diameter for this time, from the seventh page of the month of the Nautical Almanac, increase the semi-diameter by the correction in Table XV. add this augmented semi-diameter to, or subtract it from the observed altitude according as the lower or upper limb was observed (by a fore-observation) subtract the dip of the horizon taken from Table XIII. and add the correction for parallax and refraction (which may be easily found by Table XIX. by subtracting the correction found in that table from 57′ 42″) and the sum will be the correct central altitude.

EXAMPLE I.

Suppose that on the 27th of June, 1820, sea account, in long. 80° W. from Greenwich, the meridian altitude of the moon's upper limb was observed to be 40° 0′ bearing south; required the true latitude?

June 27th, sea account, is June 26th, by Nautical Almanac, on which day the moon passed the meridian of Greenwich at 12h. 45m. and the next day at 13h. 46m. the daily difference being 61m. In Table XXVIII. under 60 (which is the nearest number to 61 in the table) and opposite to the long. 80°, stand 13m. which added to 12h. 45m. gives the time of passing the meridian, June 26d. 12h. 58m.

	D.	H.	M.
☽ passes merid. ....June	26	12	58
Ship's long. 80° in time		5	20
Time at Greenwich June.......	26	18	18

June 26, midnight decl.	27°	24′	S.
June 27, at noon.............	26	10	S.
Difference	1	14	
With this difference 1° 14′, and the time at Greenwich 18h. 18m. I enter Table XXX. and find the correction........	0°	39′	
This subtracted from.........	27	24	S.
Gives the required decl........	26	45	S.

Alt. ☽'s upper limb......	40°	0′	
Subtract		20	
	39	40	
Add Tab. XXIX.........		43	
☽'s true alt.............	40	23	
☽'s zen. dist............	49	37	N.
☽'s declination	26	45	S.
Latitude	22	52	N.

EXAMPLE II.

Suppose that on the 27th September, 1820, sea account, in long. 90° E. the meridian altitude of the moon's lower limb was observed 50° 0′, bearing south, required the true latitude?

September 27, sea account, is September 26, by the Nautical Almanac, on which day the moon passed the meridian of Greenwich at 16h. 17m. and the preceding day at 15h. 19m. differing 58m. in Table XXVIII. under 58′ and opposite the long. 90° are 14m. which subtracted from 16h. 17m. leaves 16h. 3m. the time of passing the meridian of the place of observation.

	D.	H.	M.
☽ passes merid. Sept.	26	16	3
Long. 90° E. in time		6	0
Time at Greenwich Sept.	26	10	3

Decl. Sept. 26 at noon	25°	11′	N.
at midnight	26	41	N.
Difference	1	30	
With this difference 1° 30′ and the time at Greenwich 10h. 3m. I find the correction of Table XXX.	1°	15′	
Declination at noon..........	25	11	N.
True declination	26	26	N.

☽'s obs. alt. lower limb ..	50°	0′	
Add		12	
Sum	50	12	
Corr. Tab. XXIX. add ...		36	
☽'s correct alt.	50	48	
☽'s zenith distance......	39	12	N.
☽'s declination	26	26	N.
Latitude	65	38	N.

EXAMPLE III.

Suppose that on the 29th November, 1820, sea account, in the longitude of 150° W. the meridian altitude of the moon's upper limb was observed 60° 26′, bearing north, required the true latitude?

Nov. 29, sea account, is Nov. 28, by the Nautical Almanac, on which day the moon passed the meridian of Greenwich at 19h. 20m. and the next day at 19h. 59m. differing 39m. In Table XXVIII. under 39′ or 40′ and opposite the longitude of 150° stand 17m. which added to 19h. 20m. gives 19h. 37m. the time of passing the meridian of the place of observation.

	D.	H.	M.
☽ passes merid. Nov.	28	19	37
Long. 150° W. in time		10	0
Time at Greenwich Nov.	29	5	37
☽'s decl. Nov. 29 at noon	0°	27′ N.	
at midnight ..	2	22 S.	
Sum	2	49	

With this sum 2° 49′, and the time at Greenwich 5h. 37m. I enter Table XXX. and find the corr. of decl. ....1° 19′

Decl. Nov. 29 at noon	0	27 N.
True declination	0	52 S.

Obs. alt. ☽'s upper limb ..	60°	26′
subtract		20
	60	6
Corr. Tab. XXIX. add		28
☽'s corr. alt.	60	34
☽'s zen. dist.	29	26 S.
☽'s declination	0	52 S.
Latitude	30	18 S.

In this example you must refer to notes 1. and 2. page 125.

TO FIND THE LATITUDE

BY THE

MERIDIAN ALTITUDE OF A PLANET.

FROM page 4th of the month of the Nautical Almanac, take out the time of the planet's passing the meridian on the day nearest to that on which the observation was made; this will be nearly the time of passing the meridian of the place of observation.*

Turn the ship's longitude into time, and add it to the time of passing the meridian, when in west longitude, but subtract in east, the sum or difference will be the time at Greenwich nearly.† Take out the planet's declination, from the Nautical Almanac, for the times immediately preceding and following the day of observation, and note the difference of the declinations when they are of the same name, but their sum when of different names, and find the interval between these times marked in the Nautical Almanac; take also the difference between the time first marked in the Nautical Almanac and the time of observation at Greenwich (remarking that this time is one day less than the sea account;) then as the former interval of time is to the latter, so is the sum, or difference of declinations, to the correction of the declination taken first from the Nautical Almanac, additive if that declination be increasing, but subtractive if decreasing; the sum or difference will be the declination of the planet at the time of observation. But you must observe that if the correction of declination be greater than the declination first marked in the Nautical Almanac, their difference will be the sought declination, which will be of a different name from the first declination.

From the observed altitude of the planet (taken by a fore observation) subtract the refraction and dip, the latter being in general about four minutes, and the remainder subtracted from 90° will give the correct zenith distance nearly; with which, and the declination, the latitude may be found as by an observation of the sun.

* If you wish to find the time of passing the meridian more accurately, you must take a proportional part of the difference of the times of coming to the meridian given in the Nautical Almanac, in the same manner as in finding the declination of the planet.

† This time is also given by a chronometer, as in note page 124, or in the explanation prefixed to the tables.

EXAMPLE.

Suppose that on the 23d October, 1820, in long. 65° W. Jupiter passed the meridian to the southward; his meridian altitude being observed was 45° 20′, and the dip 4′; required the true latitude?

October 23, sea account, is October 22, by the Nautical Almanac; now on October 19, by the N. A. Jupiter passes the meridian at .... 9h. 26m.
To this add the long. 65° W. in time 4 20

Time at Greenwich, October 22d. 13 46

Jupiter's declination, October 19	7°	39′	S.
—————— October 25	7	46	S.
Difference		7	

Then say, as 6 days (which is the interval between October 19 and October 25) is to 3 days 13¾ hours (which is the time elapsed between October 19th and October 22d. 13¾ h.) so is 7 minutes to 4 minutes, which added to 7° 39′ S. gives 7° 43′ S. the true declination at the time of observation.

Jupiter's observed altitude	45°	20′	
Subtract 4 minutes for dip and 1′ for refraction		5	
True altitude	45	15	
Zenith distance	44	45	N.
Declination	7	43	S.
Latitude	37	2	N.

TO FIND THE LATITUDE BY DOUBLE ALTITUDES.

FORM I.—*By double altitudes of the Sun.*

WHEN by reason of clouds, or from other causes, a meridian altitude cannot be obtained, the latitude may be found by two altitudes of the sun, taken at any time of the day, the interval or elapsed time between the observations being measured by a good watch or chronometer, noticing the seconds, if possible, or estimating the times to a third or a quarter of a minute, if the watch is not furnished with a second-hand. The observed altitudes of the sun must be corrected, as usual, for the semi-diameter, dip, refraction and parallax, in the same manner as in finding the latitude by a meridian altitude. When great accuracy is required, the declination must be found at the time of each observation, using the *third* method of solution hereafter given, but when the sun's declination varies slowly, or the elapsed time is small, it will in general be sufficiently accurate to find the sun's declination for the *middle time between two observations*, and to consider it as invariable during the observations, computing the latitude by the first or second method.

This manner of finding the latitude is in general most to be depended upon where the sun's meridian zenith distance is great. If the sun passes the meridian near to the zenith, much greater care must be taken in measuring the altitudes and noting the times, than would be necessary under other circumstances. The nearer the sun is to the meridian at the time of one of the observations, the more correct the result will commonly be. In general the elapsed time ought to be as great or greater than the time of the nearest observation from noon. Similar remarks may be made upon every one of the following forms.

In all these observations it is supposed that the watch moves uniformly according to *apparent* time, measuring twenty-four hours from the time of the sun's passing the meridian on two successive days at the same place of observation. If the watch gain or lose on apparent time, supposing the observer

to be at rest, a correction must be applied for the gain or loss during the time elapsed between the observations, so as to obtain accurately the *elapsed time* or *hour angle*. It is not required that the watch should be regulated so as to give precisely the *hour* of observation; the only thing required is to find the *elapsed time* with all possible accuracy.

FORM II.—*Double Altitudes of a Star.*

Double altitudes of a fixed star may be used in finding the latitude, and the calculation is almost identical with that of double altitudes of the sun; the only difference consists in adding a small correction to the elapsed apparent time between the observations, on account of the daily acceleration of 3′ 56″ in the time a star comes to the meridian on successive days. This correction is obtained to a sufficient degree of accuracy by adding *one second* for every *six minutes* of the elapsed time; the sums will be the *corrected elapsed time* or *hour angle*, to be used in the calculation, either by the *first, second or third* method. Thus if the elapsed time was 3h. or 180m. the correction would be $\frac{180}{6}$ or 30″, making the corrected elapsed time or hour angle 3h. 0′ 30″. If great accuracy is required, find the correction in Table XXXI. in the column marked at top 3′ 56″, and at the side with the elapsed time. In the preceding example, this Table would give 29″ for the correction, instead of 30″.

In observations of a fixed star the altitudes are to be corrected for dip and refraction, as in finding the latitude by a meridian altitude. The declination of the star is to be found in Table VIII.*. With these altitudes, the declination and the hour angle, the calculation is to be made by either of the three methods hereafter given.

The chief difficulty in observations of this kind with a fixed star is the want of a good horizon in the night time. The method, however, might sometimes be used with success, soon after the dawn of day, or late in the evening twilight, at a time when the horizon is well defined, and the star sufficiently bright to bring its reflected image to the horizon. Sometimes a good horizon is produced by the aurora borealis, in which case a good observation might be made with stars in the northern horizon, but a single observation of the polar star will answer the same purpose, and be much more simple.

FORM III.—*Double Altitudes of a Planet.*

Double altitudes of a planet (particularly Jupiter and Venus, on account of their great brightness) might sometimes be used with success. The observed altitudes must be corrected for dip and refraction. The parallax and semi-diameter being small may be neglected, except in cases where extreme accuracy is required. The declination of the planet is to be found in page IV. of the Nautical Almanac, for the supposed time at Greenwich. The daily variation of the time of coming to the meridian is also to be found in the same page where the hour is marked at intervals of 6 days, and thus the time elapsed between the passage of the planet over the meridian on two successive days is found; then the corrected elapsed time or *hour angle* is obtained by the following

RULE. *As the interval of time between two successive passages of the object over the meridian is to 24 hours, so is the apparent elapsed time between the observations, to the corrected elapsed time or hour angle:* Or more simply by means of Table XXXI. finding the daily variation in the time of coming to the meridian at the top† and the elapsed time at the side, the corresponding correction is to be *added* to the elapsed time when the time of coming to the meridian is *earlier* on successive days, as is generally the case, but *subtracted* if *later*, the sum or difference will be the corrected elapsed time or *hour angle* nearly.

With this *hour angle*, the *declination* and *corrected altitudes*, the latitude may be found by either of the *three* following methods of calculation.

* Or more accurately in the Nautical Almanac, if any one of the twenty-four bright stars is observed, whose place is given in that work.

† If the daily variation be less than 3 1-2 minutes, which is the smallest in the table, you may multiply the daily variation by 2 or 3, &c. and divide the result by the same number, and the correction will be obtained.

FORM IV.—*Double Altitudes of the Moon.*

Double altitudes of the moon may also be used in finding the latitude. These observations may be easily and very accurately made, but the calculation is much more complex than any of the preceding methods, on account of the great change in the moon's declination and right ascension, during the elapsed time between the observations. If, however, by the times of observation, and the longitude of the ship; or else by a chronometer, the time at Greenwich can be obtained within a few minutes; we may, from pages VI. VII. of the Nautical Almanac, find the corresponding declination, semi-diameter and horizontal parallax of the moon for *each* of these observations. With the horizontal parallax and the moon's apparent altitude, find the correction in Table XIX. which being subtracted from 59′ 42″, leaves the correction of the moon's altitude for parallax and refraction,* which is to be added to the corresponding observed altitude corrected for semi-diameter and dip, and in this way the moon's *correct* central altitude is to be obtained at *each* observation. Lastly, the time of the moon's passing the meridian on successive days in page VI. of the Nautical Almanac, gives the interval of time between two successive passages of the moon over the meridian,† and *this time is to 24 hours as the elapsed time between the observations is to the corrected elapsed time or hour angle.* With this hour angle, the correct central altitudes and the declinations, the latitude may be found by the third of the following methods of calculation, it being very rare that the two first methods can be used, on account of the great change in the moon's declination.

FORM V.—*By altitudes of two different objects, taken at the same time.*

The latitude may be obtained by observing, at the *same moment of time*, the altitudes of two heavenly bodies: as for example, (1) The sun and moon.‡ (2) The moon and a fixed star or planet. (3) A planet and a fixed star. (4) Two planets. (5) Two fixed stars. In these methods the altitudes are to be corrected as in the preceding *Forms*, for dip and refraction; also for parallax and semi-diameter when necessary, as is always the case in observations of the moon and sun. The declinations of the bodies are to be found for the supposed time of observation, reduced to the meridian of Greenwich, by means of the Nautical Almanac, or by Table VIII. for the fixed stars, as before taught. Then the difference of the right ascensions of the bodies (or that difference subtracted from 24 hours, if it exceed 12 hours) will be the *hour angle* which is to be used with these declinations and corrected altitudes in finding the latitude, by either of the two first methods if the declinations should be equal, or differ but one or two minutes, otherwise by the *third* method, which in fact may be considered as the only method to be used in this kind of observations, because, in almost all cases, the declinations of the objects differ considerably.

FORM VI.—*By altitudes of two different objects, taken within a few minutes of each other, by one observer.*

It may sometimes happen, for want of *two* good instruments, or from not having *two* observers, that the preceding Form V. cannot be employed. In this case the whole of the observations may be made by one person, noticing the interval between the observations, and making the calculation as in the following Form VII. But it is in general much better to make the observations as near to each other as possible, and then by a very simple process the calculation may be reduced to that of Form V. in which the observations are taken *at the same moment*. This is done by observing the *first object* twice, *before* and *after* observing the *second object*. For if the interval of time between these three observations are equal, as, for example, one minute, or

* When extreme accuracy is not required, we may find the correction for parallax and refraction from Table XXIX. which, if the altitudes are large, will not vary much from the truth.

† This time is given to minutes which in general is sufficient, because if the elapsed time is small, the effect of this correction would be only a few seconds. It might be obtained more accurately by means of the right ascensions of the sun and moon, using the second differences, as taught in the Appendix.

‡ A particular case of this method occurs in taking a lunar observation, which will be treated of separately, because the distance of the two bodies being known, the calculation becomes more simple.

Two minutes, the half sum of the two altitudes of the first object may be taken for the altitude corresponding to the time of observing the second altitude, and the calculation may then be made as in Form V. Thus, suppose at 10h. 2m. A. M. per watch, the altitude of Sirius was 17° 54′, at 10h. 4m. per watch the altitude of Capella 60° 45′, and at 10h. 6m. per watch the altitude of Sirius was again observed and found to be 17° 58′. In this case the intervals of time are exactly two minutes, therefore the half sum of the altitudes of Sirius is to be taken 17° 56′, and combined with the altitude of Capella 60° 45′, supposing *both* to have been observed at 10h. 4m. per watch. This is the most simple form in which an observation of this kind can be made by one observer.

If, from any cause whatever, the observations cannot be taken at exactly equal intervals, the altitude of the first object, at the time of observing the second object, may be found by proportion, supposing the altitudes to vary uniformly during the few minutes of the observations. Thus in the preceding example, suppose the altitudes and the two first noted times to remain unaltered, but the last observation of Sirius to have been at 10h. 10m. per watch, (instead of 10h. 6m.) In this case, during the 8 minutes of time elapsed between 10h. 2m. and 10h. 10m. Sirius would have risen 4′ (from 17° 54′ to 17° 58′), therefore, by proportion, it is found that in 2 minutes (the time elapsed between 10h. 2m. and 10h. 4m.) the star would have risen 1′, and the altitude would have increased from 17° 54′ to 17° 55′: therefore at the time 10h. 4m. per watch, the altitude of Sirius must be taken at 17° 55′, the altitude of Capella 60° 45′, and with these quantities considered as observed at this last mentioned time 10h. 4m. the calculation must be made as in Form V.

There are several advantages attending these two last Forms V. VI. since no allowance is necessary for the change of place of the ship; the observations can be immediately made, in a short interval of fair weather, when the common method of double altitudes might fail from the intervention of clouds; the time can also be obtained at the same operation, &c.

Form VII.—*By altitudes of two different objects, taken at different times.*

This method differs but very little from the two last; the altitudes are to be corrected in the same manner for dip and refraction, also for parallax and semi-diameter when necessary. The right ascension and declination of *each* object is to be found for the supposed time of observing *that* object reduced to the meridian of Greenwich. Then the apparent elapsed time between the observations, is to be turned into sidereal time, which may be done with sufficient accuracy as in the Form II. by adding *one second* for every *six minutes* of the elapsed time, the time thus corrected is to be added to the right ascension of the body first observed: the difference between this sum and the right ascension of the body last observed is the *hour angle.** This, with the declinations and corrected altitudes, are to be used in finding the latitude by the *third* of the following methods of calculation, it being very rarely the case that the first or second methods can be used on account of the difference of the declinations. These three last forms, when a fixed star or planet is used, are restricted very much from the want of a good horizon in the night; they are best adapted to the morning and evening twilight.

GENERAL REMARKS.

Having thus explained several of the different *forms* of making these observations, and the manner of finding in each form the *hour angle*, the *declinations* and the *correct central altitudes*, we shall now give three different methods of calculating the latitude, and shall illustrate the rules by proper examples. In the *first* and *second* methods the declination is supposed to be the *same* at both observations, which is true as it respects observations of a fixed star, and is in general sufficiently correct for common observations of double altitudes of the sun. The first of these methods is direct and simple, not embarrassed with much variety of cases, requiring only ten openings of the Table XXVII. without any halving or doubling of the logarithms, or the use

* If this difference exceed 12 hours, subtract it from 24 hours, and use the remainder as in *form V.*

of natural or versed sines. This method is in fact nearly, if not fully, as short as the *second* or approximative method invented by Mr. Douwes, and which was exclusively used in the former editions of this work. This second, or Douwes' method, is liable to the objection, that the calculation must sometimes be repeated several times before a true solution can be obtained, and then it becomes extremely troublesome. This difficulty does not occur in the first method, and on this account, as well as for its remarkable simplicity, it is always to be preferred.

The *third* method embraces the general solution of the problem in the case where the variation of declination is noticed. This increases the labour considerably, and renders the solution more complex in its cases. It is, however, believed, that this method (drawn up in its present form by the author of this work) will be easily understood by navigators, and that they will thus be enabled to determine the latitude with considerable accuracy in cases where it might be of the utmost importance to know it, and where other methods could not be resorted to on account of bad weather. This method is nearly, if not quite, as short as that published by Dr. Brinkley in the Nautical Almanac of 1825, and does not require, like his method, a second or third, or even a greater number of operations.

If the observer should change his place or station during the elapsed time between the observations, a correction must be applied to one of the altitudes on this account. The manner of doing this is shown in the following examples V. and VI.

It may be observed, that in like manner as there are two latitudes corresponding to the *same* meridian altitude of the sun, according as the zenith is north or south of the sun when on the meridian; so in double altitudes there are generally two latitudes, corresponding to the proposed altitudes, according as the zenith and north pole are on the same side or on different sides of the *arc* or *great circle* passing through the two observed bodies, or through the two places of the same body; and it therefore becomes necessary to notice (at the time of observation) how the zenith and north pole are situated with respect to this great circle.

To estimate the effect of small errors in the observations.

When running in with the land, or crossing a dangerous parallel with no other means of obtaining the latitude than by double altitudes, it becomes a matter of great importance to ascertain the possible error of the latitude thus computed, arising from supposed errors in the observed altitudes, or in the elapsed time. The differential expressions in spherical trigonometry afford methods of doing this, but they are not adapted to the nature of this work, on account of the complication and variety of cases. The following method, though long, is general and infallible, and was once used by the writer in a case of great anxiety and danger.

RULE. After having computed the latitude by either of the three following methods, using the observed altitudes* and elapsed time, *repeat the operation*, varying the altitude you suspect may be erroneous by 2′ or 3′, (or whatever you suppose the limit of the error in that altitude may be) the difference between this *second* latitude and that first computed, is the effect of the supposed error in that altitude. If you suspect the second altitude also to be erroneous, the operation may be again repeated, varying this second altitude 2′ or 3′ (or whatever the limit may be supposed) but using the first observed altitude and elapsed time, comparing this *third* computed latitude with the *first*, the difference is the effect of this supposed error in the *second* altitude. Finally, if the elapsed time is supposed to be erroneous, the operation may be again repeated, using the observed altitudes and varying the elapsed time by 20 or 30 seconds (or whatever the limit of this error may be supposed) the difference between this *fourth* latitude and that *first* computed, is the effect of this supposed error of the elapsed time.

Thus, suppose the first computed latitude was 30°, the second 30° 1′, the

* Meaning the observed altitudes, corrected as usual for dip, refraction, parallax and semi-diameter, if necessary.

third 30° 3′, the fourth 30° 2′. The error arising from the first altitude would be 1′, that from the second altitude 3′ and that from the elapsed time 2′. If all these errors existed at the same time, the greatest limit of the error would be the sum of these quantities or 6′, so that the true latitude would be 30° ± 6′ or between 29° 54′ and 30° 6′. In this way the limit of the error may be obtained in any case, and the degree of confidence that may be placed in the observation obtained. This examination is sometimes very necessary, because the objects may be so situated, that a small error in the observations might produce a considerable change in the computed latitude. It may be observed that the error of one observation is frequently corrected in whole or in part, by the error of the other; the one tending to increase the latitude, the other to decrease it.

To find the Latitude by Double Altitudes of the Sun (or any other object) the declination being invariable.

FIRST METHOD.

In this method the log-sines, co-sines, &c. of Table XXVII. are used, and for brevity the word log. is omitted in the rule. For the convenience of writing down at once in the same line all the logarithms which occur at the same opening of the book, they are arranged in three columns, as in the following formula, and it will be very convenient to have one of these blanks prepared at the commencement of the operation, and then the logarithms may be written down in their proper places with great rapidity.

FORMULA.

Col. 1.	Col. 2.		Col. 3.
Elapsed time [P. .M] co-sec.			
Declination ....sec.	....		..........co-sec.
A ....co-sec.	co-sine		..........co-sine
½ sum alts. ....co-sine	co-sec.	B	co-sec.
½ diff. alts. ....sine	sec.		[B less than 90°, like decl. N. or S.]
C...............sine	co-sine		..........co-sine
Z [Less than 90°, north or south like bearing of Zenith.]	sec.	Z	
{E is *Sum* of B, Z, of *same* name, *difference* if of *different* name.]		E	sine
	Latitude..		sine

Rule. *(Using Table* XXVII.*)*

1. Find the elapsed time* in column P. M. take out the corresponding co-secant and put it in Col. 1.

2. Put the secant of the declination in Col. 1, its co-secant in Col. 3.

3. The sum of the logarithms in Col. 1, (rejecting 10 in the index) is the co-secant of the angle A, whose co-sine is to be put in Col. 2 and Col. 3.†

4. The sum of the logarithms in Col. 3. (rejecting 10 in the index) is the co-secant of the angle B (less than 90°) which is to be named *north* or *south*, like the declination.

5. Find half the *sum* of the two altitudes; place its co-sine in Col. 1, its co-secant in Col. 2. Find also half the difference of the two altitudes; place its sine in Col. 1, its secant in Col. 2.

6. The sum of the three lower logarithms of Col. 1. (rejecting 20 in the index) is the sine of the angle C, whose co-sine is to be placed in Col. 2, and Col. 3.†

7. The sum of the logarithms in Col. 2. (rejecting 30 in the index) is the secant of the zenith angle Z, which is to be taken out (less than 90°) and placed under B in Col. 3, naming it *north* if the zenith and north pole be

* If any other object than the sun is observed the *corrected* elapsed time or *hour angle*, found as before taught, is to be used.

† The co-sines of A and C are each written down *twice*, which reduces the number of logarithms in each example from 17 to 15.

situated on the *same* side of the arch or great circle passing through the two observed places (or objects), but *south* if the zenith and north pole be situated on *different* sides of that great circle.*

8. The angle E is found by taking the *sum* of the angles B, Z, if they are of the *same* name, or their *difference* if of *different* names, marking E *north* or *south*, like the greatest of the two angles B or Z.†

9. Put the sine of E in Col. 3. and the sum of the two last written logarithms of Col. 3. (rejecting 10 in the index) is the sine of the latitude, of the same name as E.

If the time of observation were required, it might be found by the following rule (still using Table XXVII.)

Rule.—Add the tangent of C to the secant of E, the sum (rejecting 10 in the index) is the tangent of an angle. Take out half the corresponding time in Col. P. M. (or in Col. A. M. increased by 12 hours) and this will represent the horary distance of the object from the meridian, (upper or lower) at the middle time between the two observations. Take the sum and difference between this and half the elapsed time, or hour angle, and they will be the hours and minutes distance from the meridian corresponding to both observations, expressed in apparent solar time if the sun be observed, sidereal time if a star is observed, &c.

EXAMPLE I.

Being at sea in latitude 46° 30′ N. by account, when the sun's declination was 11° 17′ N. at 10h. 2m. per watch, in the forenoon, the sun's correct central altitude was 46° 55′, and at 11h. 27m. per watch, in the forenoon, the correct central altitude was 54° 9′. Required the true latitude?

Subtracting 10h. 2m. from 11h. 27m. gives the elapsed time 1h. 25m.

Col. 1.		Col. 2.		Col. 3.	
Elap. time [P.M.] 1h.25m. co-sec.	10.73430				
Declination 11° 17′ N. ..sec.	10.00848			.... co-sec.	10.70850
A ....co-sec.	10.74278	co-sine	9.99278	.... co-sine	9.99278
½ sum alts. 50 32 .....co-sine	9.80320	co-sec.	10.11239	B 11° 28′ N. co-sec.	10.70128
½ diff. alts. 3 37 .....sine	8.79970	sec.	10.00087	[B less than 90°, named N. or S. like decl.]	
C ....sine	9.34568	co-sine	9.98907	.... co-sine	9.98907
Z [Less than 90° and N. or S. like bearing of Zenith.]		sec.	10.09511	Z 36 33 N.	
[E is sum of B, Z, if of *same* name, *difference* if of *different* name.]				E 48 01 N. sine...	9.87119
				Latitude 46 27 N. sine...	9.86026

If the sun had passed the meridian to the north of the observer, Z would have been 36° 33′ S. and E. 25° 5′ S. whose sine 9.62730 added to cos. C 9.98907 gives the sine of the latitude 9.61637, corresponding to 24° 25′ S.

In the first case (in north latitude) the tangent of C 9.35640 added to the secant E 10.17463 gives 9.53103, which, in the tangents, corresponds to 2h. 30m. nearly, whose half 1h. 15m. is the time of the middle observation from noon; adding and subtracting half the elapsed time 42m. 30s. gives the times from noon 1h. 57m. 30s. and 0h. 32m. 30s. of the observations, a small difference would be found if the calculation had been made to seconds instead of the nearest minute.

EXAMPLE II.

At sea in the latitude of 47° 19′ N. by account, when the sun's declination was 12° 16′ N. at 10h. 24m. A. M. per watch, the sun's correct central alti-

* In observations of the sun the angle Z may in general be called *north*, if the zenith be *north* of the sun when on the meridian at its greatest altitude, but *south* if the zenith be then south of the sun. When the object passes the meridian near the zenith, it may be doubtful whether it be *north* or *south*, in which case the latitude may be computed upon both suppositions, and that one selected which agrees best with the estimated place of the ship, and this extra labour is very small. But observations on an object passing near the zenith, are liable to great errors, and had better be rejected.

† This case is easily remembered, because *s* is the first letter of *same* and *sum*, and *d* the first letter of *different* and *difference*.

tude was 49° 9′, at 1h. 14m. P. M. per watch, his correct central altitude was 51° 59′. Required the latitude?

Subtracting 10h. 24m. from 1h. 14m. increased by 12h. leaves the elapsed time 2h. 50m.

Col. 1.		Col. 2.		Col. 3.	
Elap. time [P.M.] 2h.50m. co-sec.	10.44077				
Declination 12° 16′ N. ..sec.	10.01003	....		co-sec.	0.67272
A ....co-sec.	10.45080	co-sine	9.97087	.... co-sine	9.97087
½ sum. alts. 50 34 .....co-sine	9.80290	co-sec.	10.11218	B 13° 08′ N. co-sec.	10.64359
½ diff. alts. 1 25 .....sine	8.39310	sec.	10.00013	[B less than 90°, named N. or S. like decl.]	
C ....sine	8.64680	co-sine	9.99958	.... co-sine	9.99958
Z [Less than 90° and N. or S. like bearing of Zenith.]		sec.	10.08276	Z 34 16 N.	
[E is sum of B, Z. if of *same* name, *difference* if of *different* name.]				E 47 24 N. sine...	9.86694
				Latitude 47 20 N. sine...	9.86652

If the sun had passed the meridian to the north of the observer, Z would have been 34° 16′ S. E. 21° 08′ S. its sine 9.55695 added to cos. C 9.99958 gives 9.55653, the sine of the latitude 21° 7′ S.

If the observed object in this example had been a fixed star, with the same declination 12° 16′ N. the same altitudes 49° 9′, 51° 59′, but the elapsed time 2h. 49m. 32s., the calculation would have been exactly as above. For by adding, according to the rule heretofore given, *one second* for every *six minutes* of elapsed time, which in this case would be 28 seconds, the corrected elapsed time would be 2h. 50m. and every part of the work would be as above.

If the planet Mars had been observed, at the same corrected altitudes, on the 19th June, 1820, in a place where his declination at the middle time between the two observations was, by the Nautical Almanac, 12° 16′ N. and the elapsed time 2h. 49m. 46s. the calculation would still be the same. For, by the Nautical Almanac, it appears that Mars passes the meridian on the 19th and 25th of June, at 4h. 21m. and 4h. 9m. accelerating 2 minutes per day. This being less than the numbers in Table XXXI. is to be doubled (as in note to Form III.) and the elapsed time being found at the side, the corresponding correction 28″ halved and added to the elapsed time 2h. 49m. 46s. gives the hour angle 2h. 50m. to be used as above, all the work being the same. Proceed in like manner if the moon was observed at a time when the declination varies but little.

EXAMPLE III.

Being at sea, in latitude 50° 40′ N. by account, when the sun's declination was 20° 0′ S. at 10h. 17m. A. M. per watch, the sun's correct central altitude was found to be 17° 13′, at 11h. 17m. per watch, the correct central altitude was found to be 19° 41′. Required the latitude?

Subtracting 10h. 17m. from 11h. 17m. gives the elapsed time 1h.

Col. 1.		Col. 2.		Col. 3.	
Elap. ti. [P.M.] 1h. 0m. co-sec.	10.88430				
Declination 20° 0′ S. sec. ..	10.02701	....		.... co-sec.	10.46593
A .... co-sec.	10.91131	co-sine	9.99670	.... co-sine	9.99670
½ sum alts. 18 27 ... co-sine	9.97708	co-sec.	10.49966	B 20° 10′ S. co-sec.	10.46263
½ diff. alts. 1 14 .... sine..	8.33292	sec. ..	10.00010	[B less than 90° named N. or S. like dec.]	
C .... sine..	9.22131	co-sine	9.99390	.... co-sine	9.99390
Z [Less than 90° and N. or S. like bearing of Zenith.]		sec. ..	10.49036	Z 71 8 N.	
[E is sum of B, Z, of *same* name, *difference* of *different* name.]				E 50 58 N. sine..	9.89030
				Latitude 50 00 N. sine..	9.88420

If the sun had passed the meridian to the north of the observer, Z would have been 71° 08′ S. and E 91° 18′ S. whose sine 9.99989 added to 9.99390 gives the sine of the latitude 9.99379, corresponding to 80° 20′ S.

EXAMPLE IV.

Being at sea in the latitude of 60° 0′ N. by account, when the sun was on the equator (or had no declination) at 1h. 0m. P. M. per watch, his correct central altitude was 28° 53′, and at 3h. 0m. P. M. per watch, the correct central altitude was 20° 42′. Required the true latitude?

Col. 1.	Col. 2.	Col. 3.
Elap. time [P. M.] 2h. 0m. co-sec. 10.58700		
Declination 0............ sec. 10.00000	....	.... [co-sec. *Infinite.*]
A.......... 30° 0′ co-sec. 10.58700	co-sine 9.98494	.... [co-sine 9.98494]
½ sum. alts. .. 24 47½ co-sine 9.95801	co-sec. 10.37745	B 0° 0′ [co-sec. *Infinite.*]
½ diff. alts. ... 4 5½ sine .. 8.85340	sec. .. 10.00110	[B less than 90° named N. or S. like dec.]
C.................. sine .. 9.39841	co-sine 9.98594	.... co-sine 9.98594
Z [Less than 90°, and N. or S. like bearing of Zenith.]	sec. .. 10.34943	Z 63° 26′ N.
[E is *sum* of B, Z, if of *same* name, *difference* of *diff.* name]		E 63 26 N. sine 9.95154
		Latitude 59 59 N. sine 9.93748

The calculations would have been the same for south latitude, which would be 59° 59′ S. The computation of A and B might have been dispensed with, for when the declination is nothing, B is nothing, and A is equal to the elapsed time 2h. turned into degrees by Table XXI. being in this example 30°; in this case all the terms included between the brackets [ ] might be omitted.

In the preceding examples both altitudes were supposed to be taken at the same place or station; but as that is seldom the case at sea, the necessary correction for any change of place must be made in the following manner.

Let the bearing of the sun be observed by the compass at the instant of the first observation; take the number of points between that bearing and the ship's course, corrected for lee-way, if she makes any; with which, if less than eight, or with what it wants of 16 points, if more than eight, enter the traverse table, and take out the difference of latitude corresponding to the distance run between the observations. *Add* this difference of latitude to the first altitude, if the number of points between the sun's bearing and the ship's course were less than eight; but *subtract* the difference of latitude from the first altitude, if the number of points were more than eight, and that altitude will be reduced to what it would have been if observed at the same place where the second was.* This *corrected* altitude is to be used with the second *observed* altitude in finding the latitude by the above rule. The latitude resulting, will be that of the ship at the time of taking the second altitude, and must be reduced to noon by means of the log.

EXAMPLE V.

In a ship running N. by E. ¾ E. per compass, at the rate of 9 knots per hour, at 10h. 0m. A. M. per watch, the sun's correct central altitude was found to be 13° 18′ bearing S. ¾ E by compass, and at 1h. 40m. P. M. per watch, the sun's central altitude was found to be 14° 15′, the latitude by account being 49° 17′ N. and the sun's declination 23° 28′ S. Required the true latitude?

* This is the only correction necessary to make full allowance for the run of the ship; and the unexperienced calculator must take care not to fall into the error of applying a correction to the elapsed time, as is directed in several works of note, particularly in the "*Complete Navigator*," by Dr. Macka . This will appear evident by supposing in the above Example V. that a second observer, with a watch regulated exactly like that used by the first, was at rest at the place of the second observation. Then at the first observation *at the same moment of time by both watches*, the first observer would find the sun's altitude 13° 18′, and the second observer 12° 49′. At the second observation the times and altitudes would be *alike*, so that the elapsed time found by both observers would be the same, and the observations would require no correction, except what arises from reducing the altitude from 13° 18′ to 12° 49′, because the second observer is supposed to be at rest, and his observation requires no correction.

The correction to the first altitude.

The time elapsed between the observations was 3h. 40m. and in that time the ship sailed 33 miles upon the course N. by E. ¾ E. which makes an angle of 13½ points with the sun's bearing at the first observation S. ¾ E. the complement of which to 16 points is 2½ points. Now in Table I. the course 2½ points, and distance 33m. give 29 miles difference of latitude, which must be subtracted from the first altitude 13° 18′ because the ship sailed above 8 points from the sun; therefore the first altitude corrected will be 12° 49′, which must be used in the rest of the work.

Col. 1.	Col. 2.	Col. 3.
Elap. time [P.M.] 3h. 40m. co-sec. 10.33559		
Declination 23° 28′ S. sec. .. 10.03749	....	.... co.sec. 10.39988
A .... co-sec. 10.37308	co-sine 9.95704	.... co-sine 9.95704
½ sum alts. 13 32 ... co.sine 9.98777	co-sec. 10.63076	B 26° 05′ S. co-sec. 10.35692
½ diff. alts. 0 43 ... sine .. 8.09718	sec. .. 10.00003	[B less than 90° and named N. or S. like declination.]
C .... sine .. 8.45803	co-sine 9.99982	.... co-sine 9.99982
Z [Less than 90° and N. or S. like bearing of Zenith.]	Z sec. 10.58765	Z 75 01 N.
[E is sum of B, Z, if of *same* name, *difference* if of *different* name.]		E 48 56 N. sine .. 9.87734
	Latitude	48 54 N. sine .. 9.87716

If the sun had passed the meridian to the north of the observer, Z would have been 75° 01′ S. and E 101° 06′ S. whose sine 9.99180 added to 9.99982 gives the sine of the latitude 9.99162 corresponding to 78° 47′ S.

EXAMPLE VI.

Sailing N. E. ½ E. by compass, at the rate of 9 knots an hour, at 0h. 31′ 40″ P. M. per watch, the altitude of the sun's lower limb, was 28° 20′ above the horizon of the sea, the eye being elevated 20 feet above the surface of the water, and the sun's bearing by compass S. by W. and at 2h. 58m. 20s. P. M. by watch, the altitude of the sun's lower limb was 16° 41′ above the horizon, the eye being elevated as before, the latitude by account, at the time of the last observation, 48° 0′ north, and the declination 13° 17′ south. Required the true latitude at taking the last observation?

The correction of these altitudes for semi-diameter, parallax and dip, was 12 miles additive, which makes them 28° 32′ and 16° 53′; the refraction corresponding to the first was 2 miles, and for the second 3 miles, by subtracting which we have the true central altitudes 28° 30′ and 16° 50′. Now the elapsed time between the observations was 2h. 26m. 40s. during which the ship sailed 22 miles (at 9 miles per hour) in the direction of N. E. ½ E. per compass, the bearing of the sun at the first observation S. by W. being 12½ points distant from the ship's course, and as 12½ points want 3½ of 16 points, I enter Table I. and find the course 3½ points and distance 22, corresponding to which in the latitude column is 17 miles, which subtracted from the first altitude 23° 30′ leaves the corrected first altitude 28° 13′; with this and the second altitude 16° 50′, I calculate the latitude in the following manner:

Col. 1.	Col. 2.	Col. 3.
Elap. ti. [P.M.] 2h. 26′ 40″ co-sec. 10.50232		
Declination 13° 17′ S. sec. .. 10.01178	....	.... co-sec. 10.63871
A.................. co-sec. 10.51410	co.sine 9.97861	co-sine 9.97861
½ sum alts. 22 31½ ..co-sine 9.96553	co-sec. 10.41670	B 13° 58′ S. co-sec. 10.61732
½ diff. alts. 5 41½ ..sine 8.99643	sec. 10.00215	[B less than 90°, and named N. or S. like decl.]
C.................. sine 9.47603	co-sine 9.97962	.... co-sine 9.97962
Z [Less than 90°, and N. or S. like bearing of Zenith.]	Z sec. 10.37708	Z 65 11 N.
[E is sum of B, Z, if of *same* name, *difference* if of *diff.* name.]		E 51 13 N. sine 9.89183
	Latitude	48 03 N. sine 9.87145

If the sun had passed the meridian to the north of the observer, Z would have been 65° 11′ S. and E 79° 09′ S. whose sine 9.99217 added to co-sine of C 9.97962 gives the sine of the latitude 9.97179, corresponding to 69° 34′ S.

EXAMPLE VII.—*(Same as Dr. Brinkley's Nautical Almanac for 1800.)*

The latitude by account 6° 30′ N. sun's declination 5° 30′ N. the sun's correct central altitudes were found to be 35° 21′ and 70° 01′, with an elapsed time between the observations of 2h. 20′. Required the latitude, the sun passing the meridian south of the observer?

Elap. time [P.M.] 2h. 20m. co-sec.	10.52186				
Declination 5° 30′ N. sec. ..	10.00200	....		.... co-sec.	11.01343
A.................. co-sec.	10.52386	co-sine	9.97962	.... co-sine	9.97962
½ sum alts. 52 41 .... co-sine	9.78263	co-sec.	10.09947	B 5° 46′ N. co-sec.	10.99805
½ diff. alts. 17 20 .... sine ..	9.47411	sec. ..	10.02018	[B less than 90°, named N. or S. like dec.]	
C.................. sine ..	9.73060	co-sine	9.90170	.... co-sine	9.90170
Z [Less than 90°, and N. or S. like bearing of Zenith.]		Z sec.	10.00097	Z 3 50 N.	
[E is *sum* of B, Z, if of *same* name, *difference* if of *dif.* name.]				E 9 36 N. sine ..	9.22211
		Latitude		7 38 N. sine ..	9.12381

If the sun had passed to the meridian *north* of the observer, Z would have been 3° 50′ S. and E = 1° 56′ N. whose sine 8.52810 added to the co-sine of C 9.90170 is 8.42980, which is the sine of the other latitude 1° 32′ N. so that in this example both latitudes are *north*.

SECOND METHOD

of finding the latitude by double altitudes of the sun, when the variation of declination is neglected.

This method of finding the latitude depends on a set of tables, marked XXIII. in this collection, first prepared by Mr. Douwes, containing three logarithms titled Half Elapsed time, Middle time, and Log. rising. The two former are arranged together as far as six hours, the latter is placed at the end of the table, and is extended in the present edition as far as 12 hours. The table with the proper title must be entered at the top with the hour, at the side with the minute, and in the column marked at the top with the seconds, the corresponding number will be the sought logarithm, to which must be prefixed the index of the log. under 0″ in the same horizontal line. Thus to the time 3h. 52′ 10″ correspond the log. half-elapsed time 0.07138, log. middle time 5.22965, and log. rising 4.67274. In general it will be sufficiently exact to take these logarithms to the nearest 10 seconds, particularly when the sun's zenith distance is great; but if the log. to the nearest second is required, it may be found by taking the difference of the tabular logarithms corresponding to the next greater and next less time, and saying as 10″ is to that difference, so are the odd seconds of time to the correction of the first tabular logarithm, additive, if increasing, subtractive, if decreasing. Thus if the log. ½ El. time corresponding to 3h. 52′ 18″ were required: the logs. corresponding to 3h. 52′ 10″ and 3h. 52′ 20″ are 0.07138 and 0.07119, whose difference is 19, then 10″ : 19 :: 8″ : 15.—This subtracted from 0.07138 leaves 0.07123, the sought logarithm. By inverting the process we may find the nearest second corresponding to any given logarithm. We shall now give the rule for calculating the latitude adapted to double altitudes of the sun.

RULE.

To the log. secant of the latitude by account (Table XXVII.) add the log. secant of the sun's declination (Table XXVII.) rejecting 10 in each index, the sum is to be called the log. ratio.

From the natural sine of the greatest altitude (Table XXIV.) subtract the natural sine of the least altitude (Table XXIV.) find the logarithm* of their difference (in Table XXVI.) and place it under the log. ratio.

Subtract the time of taking the first observation from the time of taking the second, having previously increased the latter by 12 hours when the observations are on different sides of noon by the watch; take half the remainder, which call half the elapsed time.

With half the elapsed time enter Table XXIII. and from the column of half elapsed time take out the logarithm answering thereto, and write it under the log. ratio.

* The index of this logarithm being as usual one less than the number of figures contained in the difference of those natural sines. You must also observe that the altitudes to be used are the correct central altitudes: that is, the observed altitudes corrected for dip, semi-diameter, parallax and refraction.

Add these three logarithms together, and with their sum enter Table XXIII. in the column of middle time, where, having found the logarithm nearest thereto, take out the time corresponding, and put it under half the elapsed time. The difference between these times will be the time from noon when the greater altitude was taken.

With this time enter Table XXIII. and from the column of log. rising, take out the logarithm corresponding, from which logarithm subtract the log. ratio, the remainder will be the logarithm of a natural number, which being found in Table XXVI.* and added to the natural sine of the greater altitude, will give the natural co-sine of the sun's meridian zenith distance, which may be found in Table XXIV. Hence the latitude may be obtained by the rules of page 121.

NOTES.

1. If this computed latitude should differ considerably from the latitude by account, it will be proper to repeat the operation, using the latitude last found instead of the latitude by account, till the result gives a latitude nearly agreeing with the latitude used in the computation.

2. This method is best suited to situations where the sun's meridian zenith distance is not much less than half the latitude; for in latitudes where the sun approaches near to the zenith, the observations must be taken much nearer to noon: and the preceding rule, instead of approximating, will in some cases give the results of successive operations, wider and wider from the truth. To remedy this difficulty, a set of tables was published by Dr. Brinkley, at the end of the Nautical Almanac for 1799; but the great variety of cases incident to his method will hinder it from being generally used. Instead of Dr. Brinkley's method, we may generally use the method of arithmetical computation, called *Double Position*, which will frequently give, in a more simple manner, the required latitude, as will be shown in Example X. and in *general* it may be observed, that where Douwes' rule does not approximate, the object is most commonly so situated, as not to furnish the necessary observations to obtain a correct latitude, whatever method of computation might be used.

3. The operation is the same whether the sun has north or south declination; and also whether the ship is in north or south latitude. When the sun has no declination, the log. secant of the latitude (rejecting 10 in the index) will be the log. ratio: and when the latitude by account is nothing, the secant of the declination (rejecting 10 in the index) will be the log. ratio. This rule, as well as the former, is founded on the supposition that the declination is taken for the middle time between the observations, and that it does not vary during the elapsed time, which, however, rarely happens, and a correction ought to be applied to the latitude on this account, but this correction is generally small, and if it is large, the *third* method must be used, or the new method in the Appendix of this work.

EXAMPLE VIII.—*(Same as Example I. preceding.)*

Being at sea in latitude 46° 30′ N. by account, when the sun's declination was 11° 17′ N. at 10h. 2m. in the forenoon, the sun's correct central altitude was 46° 55′, and at 11h. 27m. in the forenoon, his correct central altitude was 54° 9′. Required the true latitude, and true time of the day when the greater altitude was taken?

	Times. H. M. S.	Alt.	Nat. Si.		
				Lat. by acc. .... 46° 30′ Sec.	0.16219
2 obs.	11 27 0	54° 9′	81055	Dec. .... 11 17 Sec.	0.00848
1 obs.	10 2 0	46 55	73036	Log. ratio	0.17067
Elap. time	1 25 0	Diff. Nat. Sines	8019	Log. Diff. Nat. Sines	3.90412
½ Elap. time	0 42 30			Log. ½ Elap. time	0.73429
	Middle time		H. M. S. 1 15 10		4.80908
	½ Elap. time		42 30		
	2 Obs. from noon		0 32 40	Its log. rising	3.00608
				Log. ratio sub.	0.17067
	Nat. numb.			685 corresponding to log.	2.83541
	Nat. sine greatest alt.			81055	

Sum is nat. co-sine ☉'s zen. dist. 81740 equal to 35° 10′ N.
☉'s declination .... 11 17 N.

Latitude in .... 46 27 N.

* Taking as usual a number of figures equal to the index of that logarithm increased by unity.

The latitude 46° 27′ differing only 3′ from the latitude by account, may be assumed as the true latitude.

By means of the time of the second observation from noon above found 32′ 40″, the error of the watch may be found; for in the present example, by subtracting 32′ 40″ from 12h. we have the time of the second observation 11h. 27′ 20″; but the time of the watch was 11h. 27′ 0″; therefore the watch was 20 seconds too slow; a small difference would be found in these numbers, if we were to proportion the logarithms of Tab. XXIII. to seconds. In the same manner the error of the watch may be found in the following examples.*

EXAMPLE IX.—*(Same as Example V. before given.)*

In this example the latitude by account was 49° 17′ N. The sun's declination 23° 28′ S. The first altitude corrected as before taught 12° 49′, the second altitude 14° 15′. From which the true latitude is required?

	H. M. S.	Alt. Nat. Si.			
			Lat. by acc.	49° 17′	Sec. 0.18554
2 Obser.	13 40 0	14° 15′=24615	Declination	23 28	Sec. 0.03749
1 Obser.	10 0 0	12 49=22183			
			Log. ratio		0.22303
Elap. time	3 40 0	Diff. nat. si. 2432	Its. log.		3.38596
½ Elap. time	1 50 0		Its log.		0.33559
	0 10 10	Time corresponding to			3.94458
	1 39 50	Its log. in col. of rising is			3.97028
		Log. ratio			0.22303
		5588	Nat. number of .... log.		3.74725
		24615			

Nat. co-sine ☉'s mer. zen. dist. 30203 = 72° 25′ N.
Declination .... 23 28 S.

Latitude .... 48 57 N.

But as the latitude by computation differs considerably from that by account, the work must be repeated.

	H. M. S.				
		Lat. last found	48° 57′		Sec. 0.18262
		Declination	23 28		Sec. 0.03749
		Log. ratio			0.22011
½ Elapsed time	1 50 0	Diff. N. sine 2432		Its log.	3.38596
Middle time	0 10 0			Its log.	0.33559
Time from noon	1 40 0	Its log.			3.94166
		Its log. in col. of rising			3.97170
		Log. ratio			0.22011
		5644 Nat. number of		log.	3.75159
		24615			

30259 Nat. cos. mer. zen. distance ...... 72° 23′ N.
Declination .... 23 28 S.

True latitude .... 48 55 N.

This latitude, differing only two miles from that used in the computation, may be depended upon as the true latitude of the ship at the time of the second observation. If the first altitude had not been corrected, the computed latitude would have been found=48° 40′ N.

* When the middle time is greater than half the elapsed time, both observations are on the same side of the meridian; otherwise, on different sides; whence it is easy to determine whether the greater altitude be observed before or after noon.

EXAMPLE X.—*(Same as Example VII. before given.)*

The latitude by account 6° 30′ N. sun's declination 5° 30′ N. the sun's correct central altitudes 35° 21′ and 70° 01′, elapsed time 2h. 20′ are given to find the true latitude.

Making the calculations with the latitude by account 6° 30′, the computed latitude by the first operation will be 8° 17′. Repeating the operation with the latitude 8° 17′, the second operation will give 7° 10′.* This must be used for a third operation, and by repeating the calculation accurately to seconds, it will require more than a dozen operations to obtain the true latitude 7° 38′, which was found by the first method by a single operation. Dr. Brinkley made the latitude 7° 30′ differing 8′ from a strict calculation by spherical trigonometry. The detail of this calculation is not here given, but is left to exercise the learner. The object of the present example is to shew how the number of operations might be decreased by the arithmetical method of *double position* before mentioned.

Lats.		Errors.		Products.
6° 30′	×	106	=	876° 16′
8 16	×	66	=	429 00
		172		)1305 16(7° 35′

Take the *error* or difference between the first assumed latitude 6° 30′ and the first computed latitude 8° 16′ equal to 106′; also the *error* or difference between the second assumed latitude 8° 16′ and second computed latitude 7° 10′ which is 66′. Multiply them *crosswise* as in the adjoined scheme, according to the usual rule of *double position*,† dividing the sum of the products 1305° 16′ by the sum of the errors 172, gives the corrected latitude 7° 35′ N. The *sum* of the products was taken in this case, because one of the assumed latitudes was *greater* and the other *less* than its corresponding computed latitude. If both computed latitudes had been *greater* or both *less* than the corresponding assumed latitudes, the *differences* of the errors and of the products ought to have been taken. It will rarely happen that more than one process of this kind will be required to give a correct result. In the present instance, however, it will be necessary; for, by repeating the operation with the assumed latitude 7° 35′, the resulting computed latitude is 7° 41½′, and the third error 6½′. Repeating anew the computation, with this and the second latitude 8° 16′ and second error 66′, the resulting latitude is 7° 38′, the same as was found by the direct computation by the first method, and as accurately as could be obtained by repeating the operations about fourteen times by the second method.

In general, when such a large number of operations are required to produce a correct result, it is a sure proof that the situation of the object is not well adapted to obtain an accurate latitude, and it would be lost labour, and lead to great mistakes to attempt it. Thus, in the present example, if the greatest altitude had been decreased only 12′ 42″, making it 69° 48′ 12″, leaving unaltered the other altitude 35° 21′ and the interval 2h. 20m. the latitude of the place of observation would be 0, or under the equator, as is easily proved by computing the altitudes of the sun for the times 1h. 17m. 50s.8 and 3h. 37m. 50s.8, under the equator when the declination is 5° 30′ N. by the rules hereafter given. Hence it appears that a change of 12′ 42″ in the greatest altitude, would alter the computed latitude from 7° 38′ to 0°, which makes an error of one degree of latitude for an error of 1⅔ miles in that altitude, and as errors in the altitudes of this magnitude are easily committed at sea, even by very good observers, it shows very clearly the defect of the method of double altitudes when the sun approaches near to the zenith. This does not arise from any defect of the method of computation, but is an inherent defect of the method itself, which no process of spherics can remedy, and there is no other resource left, in such cases, than to make use of another object to determine the latitude.

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* Slight differences will be found in these calculations by using logarithms to seven places of figures and making the calculation accurately to seconds.

† If the degrees of both latitudes are alike, the minutes only may be retained in these multiplications.

THIRD METHOD.

To find the latitude by double altitudes of the same or different objects, the declinations being different. [*See Appendix to this work.*]

This method, like the *first*, requires only the use of Table XXVII. In this rule the words sine, co-sine, &c. are written for log. sine, log. co-sine, &c. The logarithms are arranged in these columns as in the first method, according to the following formula, which ought to be written down before the calculation is commenced; this will simplify the operation, and may prevent mistakes. In this formula it is said that C is of the same *affection* as B, the meaning of which is, that if B is *less* than 90°, C also is *less* than 90°; and if B is *greater* than 90°, C also is *greater* than 90°. Likewise A is of the same affection as the hour angle, meaning that if the hour angle is *less* than 6 hours or 90°, A will be *less* than 90°; and if the hour angle *exceed* 6 hours, the angle A will *exceed* 90°.

FORMULA.

Col. 1.	Col. 2.	Col. 3.
Hour angle H [P. M.] . . sec.	. . . .	. . . . tan.
Decli. *d* [at gr. alti.] tan.	. . . . sine	
A [dif. name from d.] tan.	A [same aff. as H.] co-sec.	. . . . co-sine
D. Dec. [at le. alt.]		
B	. . . . co-sine	. . . . co-sec.
C . . . . co-sec.	C [same aff. as B] co-sine	F co-tan.
		Z [F less. 90°, diff. name from B]
	G . . . . sine	G
Least altitude . . . sec.	. . . . co-t.	. . . . sine
Greatest altitude	I tan.	[I less 90°] sec. [I named as G.]
Sum, 3 last num.	Dec. D [at least alt.]	
½ Sum . . . . co-sine	K	. . . . sine
½ S.—gr. alt.=Rem. sine	Latitude	. . sine
Sum of 4 logs. 2)		
½ Z . . . . sine		
Z [named N. or S. like bearing of Zenith.]		

In some late works on Navigation, no notice is taken of the cases where the hour angle exceeds 90°, or the distance of the objects exceeds 90°, and on that account the rules appear *less* subject to different cases than the following rule, which embraces all possible cases, and the apparent simplicity of the rules referred to, arises from their *imperfections* and *incompleteness*.

RULE.

1. Find the hour angle H,* and take out the corresponding secant, which put in Col. 1. and its tangent in Col. 3.

2. Take the declination *d*, corresponding to the *greatest* altitude, place its tangent in Col. 1. its sine in Col. 2.

3. The sum of the two logarithms in Col. 1. (rejecting 10 in the index) is the tangent of the angle A, which is *less* than 90° if the hour angle is *less* than 6 hours (or 90°) but *greater* than 90° if the hour angle is greater

* The hour angle is the same as the elapsed time in double altitudes of the sun. This time is turned into degrees by Table XXI. but it is more simple to *double* the hour angle and find it in Col. P.M. Table XXVII. and take out its corresponding tangent. If this double angle exceed 12h. reject 12h. and find the remainder in Col. A. M. and take out its corresponding tangent. In the following examples this *double angle* is marked with the letters P. M. annexed.

than 6 hours. This angle is to be marked *north* or *south*, with a different name from the declination d, at the greatest altitude.* The co-secant of A is to be placed in Col. 2. its co-sine in Col. 3.

4. Place the declination D, corresponding to the *least* altitude, below the angle A, and if they are of the* *same* name take their *sum*, but if of *different* names, take their *difference*, and call this sum† or difference, the angle B, making it *north* or *south* like the greatest of the two quantities A, D. The co-sine of B is to be placed in Col. 2. its co-secant in Col. 3.

5. The sum of the three logarithms in Col. 3. (rejecting 20 in the index) is the co-tangent of an angle F, (less than 90°) which is to be taken out and marked *north* or *south*, with a different name from B.

6. The sum of the three logarithms in Col. 2. (rejecting 20 in the index) is the co-sine of the angle C, which is to be taken *less* than 90°, if B is less than 90°, but *greater* than 90° if B is *greater* than 90°. The angle C and its co-secant are to be placed in Col. 1.

7. Place the altitudes below C, take the *half sum* of these three quantities, subtract the greatest altitude from the half sum, and note the *remainder*. Place the secant of the *least* altitude in Col. 1. its co-tangent in Col. 2. its sine in Col. 3. The co-sine of the *half sum* in Col. 1. and the sine of the *remainder* in Col. 1. The sum of the four last logarithms of Col. 1. (rejecting 20 in the index) being divided by 2, gives the sine of an acute angle, which being found and doubled, gives the zenith angle Z, which is to be named *north*, if the zenith and *north* pole are on the *same* side of the arch or *great circle*, passing through the two objects, (or the two observed places of the same object) but *south* if the zenith and *south* pole, are on the *same* side of that great circle.‡

8. Take the *sum* of the angles Z and F, if they are of the *same* name, but their difference if of *different* names; this sum or difference is the angle G, to be marked *north* or *south* like the greatest of the angles Z, F.§ The sine of G is to be placed in Col. 2.

9. The sum of the two lower logarithms of Col. 2. (rejecting 10 in the index) is the tangent of an angle I, which is to be taken out (less than 90°) and marked *north* or *south* like G. The secant of I is to be placed in Col. 3.

10. Write the declination D, corresponding to the *least* altitude below I, take their† *sum* if of the *same name*, their *difference* if of *different* names. This sum or difference is the angle K, of the same name as the greater of these two quantities. The sine of K is to be placed in Col. 3.

11. The sum of the three last logarithms in Col. 3. is the sine of the required latitude of the same name as K.

EXAMPLE XI.

Given the sun's correct central altitude 41° 33′, and his declination 14° N. After an interval of 1h. 30m. by watch, his correct central altitude was 50°, and his declination 13° 58′ N. Required the latitude, the sun being south of the observer when on the meridian?

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* This rule is easily remembered in three places in which it occurs, from the circumstance that *s* is the first letter of *sum* and *same*, and *d* the first letter of *difference* and *different*.

† If the sum be taken to find B and it exceed 180°, subtract it from 360°, and call the remainder B with a different name from A, D.

‡ This case occurs also in the first and second methods of solution, and it must be determined on the spot by the situation of the objects. In double altitudes of the sun, moon, or planets, when the elapsed time is not very great, the angle *Z* is generally to be marked with the bearing of the zenith from the observed object, when *at its greatest altitude* on the meridian, which in north latitudes, without the tropics, is in general *north*; in south latitudes, without the tropics, *south*. Sometimes when the sun passes the meridian near the zenith, it may be doubtful whether the zenith be *north* or *south*; in which case the problem may be solved for *both* cases, (which increases the labour but little) and that one of the two computed latitudes selected which agrees best with the ship's reckoning; but it is generally safest not to use observations of this kind, which are generally liable to great errors from small mistakes in the altitudes.

§ If the *sum* be taken to find G, and it exceeds 180°, subtract it from 360° and call the remainder G with a *different* name from Z or F.

Col. 1.	Col. 2.	Col. 3.
Hour ang. H 1h.30m.[P.M.3h.] sec. 10.03438	....	.... tan. 9.61722
Decli. d [at gr. alti.] 13° 58′ N. tan. 9.39569	.... sine 9.38266	
A[dif. name from d.] 15 04 S. tan. 9.43007	A[same aff. as H.] co-sec. 10.58512	.... co-sine 9.98481
D Dec. [at least alt.] 14 00 N.		
B .... 1 04 S.	.... co-sine 9.99992	.... co-sec. 11.73012
C .... 21 43 co-sec 10.42988	C [same aff. as B] co-sine 9.96770	F 2°40′ N. co-tan. 11.33215
		Z 57 18 N. [F less 90°, diff. name fm. B.]
	G .... sine 9.93738	G 59 58 N.
Least altitude ..... 41 33 sec. 10.12588	.... co-tan. 10.05243	.... sine 9.82169
Greatest altitude .. 50 00	I 44° 20′ N. tan. 9.96981	[I less 90°] sec. [I named as G.] 10.14552
Sum 113 22	Dec. D 14 00 N. [at least alt.]	
½ Sum .... 56 41 co-sine 9.73978	K 58 20 N.	.... sine 9.92993
½ S.—gr. alt.=Rem. 6 41 sine 9.06589	Latitude .... 52 7 N. sine	9.89720
Sum 4 logs. 2)19.36143		
½ Z .... 28 39 sine 9.68071		

Z .... 57 18 N. [named like bearing of Zenith.]

If the latitude had been south, Z, instead of being 57° 18′ *North*, would be 57° 18′ *South*; G, 54° 38′ S. I, 42° 37′ S. K, 28° 37′ S. and the latitude 25° 34′ S. The labour of making this extra calculation is but little, and where any doubt exists of the *name* of Z, it is best to make the computation both ways; this, however, will rarely happen. The calculations of this example, and most of the following ones, are made to the nearest minute; where great accuracy is required, it will be proper to take the logarithms and angles corresponding to seconds.

EXAMPLE XII.

The sun's correct central altitude was 32° 25′, his declination 17° S. 8 hours afterwards, by a watch, the sun's correct central altitude was 30° 8′, and declination 16° 55′ S. the observer being in a high south latitude. Required the latitude?

Col. 1.	Col. 2.	Col. 3.
Hour H 8h.[P.M.16h.=4h.A.M.] sec. 10.30103	....	.... tan. 10.23856
Decli. d [at gr. alti.] 17° 00′ S. tan. 9.48534	.... sine 9.46594	
A[dif. name from d.] 148 33 N. tan. 9.78637	A[same aff. as H.] co-sec. 10.28253	.... co-sine 9.93100
D Dec. [at least alt.] 16 55 S.		
B .... 131 38 N.	.... co-sine 9.82240	.... co-sec. 10.12644
C .... 111 51 co-sec. 10.03268	C [same aff. as B] co-sine 9.57087	F 26° 50′ S. co-tan. 10.29600
		Z 25 46 S. [F less 90°, diff. name fm. B.]
	G .... sine 9.90005	G 52 36 S.
Least altitude .... 30 08 sec. 10.06305	.... co-tan. 10.23623	.... sine 9.70072
Greatest altitude .. 32 25	I 53° 51′ S. tan. 10.13628	[I less 90°] sec. [I named as G.] 10.22922
Sum 174 24	Dec. D 16 55 S. [at least alt.]	
½ Sum .... 87 12 co-sine 8.68836	K 70 46 S.	.... sine 9.97506
½ S.—gr. alti.=Rem. 54 47 sine 9.91221	Latitude .... 53 28 S. sine	9.90530
Sum 4 logs 2)18.69650		
½ Z .... 12 53 sine 9.34825		

Z .... 25 46 S. [named like bearing of Zenith.]

If the zenith had been north of the great circle passing through the sun and moon, we should have Z=25° 46′ N. G 1° 04′ S. I 1° 50′ S. K 18° 45′ S. and the latitude 9° 18′ S.

EXAMPLE XIII.

Suppose, at the same moment of time, the moon's correct central altitude was 55° 20′, the moon's declination 0° 36′ N. the sun's correct central altitude 37° 40′, the sun's declination 0° 17′ S. The hour angle, or difference of the right ascensions of the sun and moon, being by the Nautical Almanac 5 hours or 75°. Required the latitude, supposing it to be north?

Col. 1.	Col. 2.	Col. 3.
Hour angle H 5h. (P. M. 10h.) sec. 10.58700	....	.... tan. 10.57195
Decli. d (at gr. alt.) 0° 56 N. tan. 8.02004	.... sine 8.02002	
A(dif. name from d.) 2 19 S. tan. 8.60704	A(same aff. as H.) co-sec. 11.39358	.... co-sine 9.99964
D Decl. (at least alt.) 0 17 S.		
B .... 2 36 S	.... co-sine 9.99955	.... co-sec. 11.34350
C .... 75 00 co-sec. 10.01506	C same aff. as B) co-sine 9.41295	F 0° 42′ N. co-tan. 11.91489
		Z 29 40 N. (F less 90°, diff. name fm. B.)
	G .... sine 9.70375	G 30 22 N.
Least altitude .... 37 40 sec. 10.10151	.... co-tan. 10.11241	.... sine 9.73609
Greatest altitude .. 55 20	I 33° 13′ N. tan. 9.81616	[I less 90°] sec. 10.07748 [I named as G.]
Sum 168 00	Dec. D 0 17 S. (at least alt.)	
½ Sum .... 84 00 co-sine 9.01923	K 32 56 N.	.... sine 9.73533
½ S—gr. alt.=Rem. 28 40 sine 9.68098	Latitude	25° 24′ N. sine 9.59890
Sum of 4 logs. 2)18.81671		
½ Z .... 14 50 sine 9.40839		
Z .... 29 40 N. (named like bearing of Zenith.)		

If the zenith had been south of the great circle passing through the objects, we should have Z 29° 40′ S. G 28° 58′ S. I 32° 6′ S. K 32° 23′ S. and the latitude 22° 44′ S.

EXAMPLE XIV.

Given the moon's correct central altitude 47° 37′, the moon's declination 17° 29′ S. the sun's correct central altitude, at the same time, 27° 22′, the sun's declination 8° 28′ S. the hour angle, or difference of right ascensions of the sun and moon, 5h. 40m. 28s. or 85° 7′. Required the latitude, supposed north?

Col. 1.	Col. 2.	Col. 3.
Hour H 85° 7′ (P.M. 11h. 20′ 56″) sec. 11.06939	....	.... tan. 11.06835
Decli. d (at gr. alt.) 17° 29′ S. tan. 9.49823	.... sine 9.47774	
A (dif. name from d.) 74 53 N. tan. 10.56821	A(same aff. as H.) co-sec. 10.01529	.... co-sine 9.41628
D Decl (at least alt.) 8 22 S.		
B .... 66 25 N.	.... co-sine 9.60215	.... co-sec. 10.03788
C .... 82 31 co-sec. 10.00339	C (same aff. as B) co-sine 9.09518	F 16° 43′ S. co-tan. 10.52251
		Z 39 20 N. (F less 90°, diff. name fm. B.)
	G .... sine 9.58497	G 22 37 N.
Least altitude ... 27 22 sec. 10.05155	.... co-tan. 10.28599	.... sine 9.66246
Greatest altitude .. 47 37	I 36° 37′ N. tan. 9.87096	[I less 90°] sec. 10.09548 [I named as G.]
Sum 157 50	Dec. D 8 28 S. (at least alt.)	
½ Sum .... 78 53 co-sine 9.28384	K 28 09 N.	.... sine 9.67374
½ S—gr. alt.=Rem. 31 18 sine 9.71560	Latitude	15° 41′ N. sine 9.43163
Sum of 4 logs. 2)19.05438		
½ Z .... 19 40 sine 9.52719		
Z .... 39 20 N. (named like bearing of Zenith.)		

If the zenith had been south of the great circle passing through the objects, we should have Z 39° 20′ S. G 56° 3′ S. I 58° 2′ S. K 66° 30′ S. and the latitude 52° 46′ S.

FOURTH METHOD.

To find the Latitude from the altitudes and distances found in taking a lunar observation.

This is a particular case of Form V. and is more simple than the general solution, because the true distance of the objects, computed in working the lunar observation, may be used to shorten the calculation of the latitudes; we shall therefore give a particular rule for this method.

Having the *apparent* altitudes and distance of the objects, find, by any of the methods of working a lunar observation hereafter given, the *true* distance. Find also the *true* altitudes, by correcting the apparent altitudes for parallax and refraction. The correction of the moon's altitude is equal to the *difference* between 59′ 42″ and the correction already found from Table XIX. in working the lunar observation; this *difference*, added to the moon's apparent altitude, gives her *true* altitude. In like manner the correction of the sun's altitude is equal to the difference between 60′ and the correction already found in Table XVIII. (or in Table XVII. if a star is used): this difference is to be subtracted from the sun's (or star's) apparent altitude, to obtain his *true* altitude. The time at Greenwich, corresponding to the *true* distance, having been found in working the lunar observation, take from the Nautical Almanac, for this time, the declinations of the sun and moon, as was taught in pages 110, 124, and, if great accuracy is required, the correction for second differences of the moon's declination may be noticed, as in Problem I. of the Appendix to this work. If, instead of the sun, a star is used, its declination may be obtained from Table VIII. or more accurately from the Nautical Almanac, being one of the 24 bright stars whose places are now given for every ten days in that work. From these declinations, the *north polar distances* must be found, by *adding* the declinations to 90° if *south*, or *subtracting* from 90° if *north*.

Having thus obtained the *true* distance, the *true* altitudes, the declinations and north polar distances, the latitude may be computed by the following rule, adapted exclusively to Table XXVII. writing, as before, sine, co-sine, &c. for log. sine, log. co-sine, &c. the logarithms being arranged in three columns as in the former methods.

RULE.

1. Place in Col. 1. the *true* distance and the polar distances. Take their *half sum*, subtract from this half sum the polar distance of the object which had the greatest altitude, and note the *remainder*. Put, in the same column, the co-secant of the true distance, the co-secant of the polar distance of the object having the least altitude, the sine of the *half sum*, the sine of the *remainder*. The sum of these four logarithms (rejecting 20 in the index) being divided by 2, gives the sine of an acute angle, which being found and doubled, is to be called the angle F.

2. Place in Col. 1. the true distance and the true altitudes. Take their *half sum*, and also the *remainder* or difference between the half sum and the greatest altitude. Place in the same column the co-secant of the distance (before found) the secant of the least altitude, the co-sine of the *half sum*, the sine of the remainder. The sum of these four logarithms (rejecting 20 in the index) being divided by 2, gives the sine of an acute angle, which being found and doubled, is to be called the angle Z.

3. If the zenith and *north* pole be situated on the *same* side of the great circle, passing through the two objects,* take the *sum*† of the angles F & Z for the angle G; but if the zenith and *north* pole be situated on *different* sides of that great circle, take their *difference* for the angle G. Place the co-sine of G in Col. 2.

4. Write in Col. 2. the co-tangent of the least altitude, and its sine in Col.

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* In places without the tropics, the *sum* is used generally in *northern* latitudes, and the *difference* in *southern* latitudes.

† If this sum should exceed 180° subtract it from 360° and call the remainder the angle G.

3.* The sum of the two logarithms in Col. 2. is the tangent of the angle I, which is to be taken less than 90°, and marked *south* if the angle G is *less* than 90°, but *north* if G *is more than* 90°. Place the secant of I in Col. 3.

5. Place the declination corresponding to the least altitude, below I; Take their *sum* if of the *same* name, but their *difference* if of *different* names; call this sum or difference the angle K, and mark it with the same name as the greatest of the two quantities. Place the sine of K in Column 3.

6. The sum of the three logarithms in Col. 3. (rejecting 20 in the index) is the sine of the latitude of the same name as K.

Having found the latitude, the hour may be obtained by means of the true altitude and declination of the sun or star, by any of the usual methods hereafter given for that purpose; but, if the last of the observed altitudes was that of the sun or star, the horary distance of that object from the meridian might be obtained more simply by the following rule, adapted to Table XXVII.

RULE.—Add the tangent of the angle G, the sine of the angle I, the secant of the angle K, the sum, rejecting 20 in the index, is the tangent of an angle; take out the corresponding time in the Column P. M. or in the Column A. M. increased by 12 hours, half of either of these times is the horary distance of the lowest observed object from the upper or lower meridian, whence the hour may be obtained directly if it be the sun, but if it be the star (or moon) it is obtained by applying its horary distance to the hour of passing the meridian, according to the usual methods of finding the time from an altitude of a fixed star, or the moon.

EXAMPLE.—*(Same as Dr. Brinkley's N. A. 1825.)*

May 19d. 8h. 6m. P. M. in the longitude of 7h. 23m. west, it was found by working a lunar observation that the correct distance of the centres of the sun and moon was 90° 57′ 20″; true altitude of the sun's centre 11° 33′ 12″; true altitude of the moon's centre 27° 32′ 18″. At the same time by the Nautical Almanac the sun's declination was 19° 56′ 48″ N. the moon's declination 18° 55′ 48″ N. Required the latitude and hour by this observation?

Col. 1.				Col. 2.				Col. 3.	
True distance	90° 57′ 20″	co-sec.	10.00000						
P. dist. at le. alt.	70 03 12	co-sec.	10.02687						
P. dist. at gr. alt.	76 04 12								
Sum	237 04 44			G is *sum* of F, Z, if *north* pole and *zenith* are on *same* side of of great circle, but their *difference* if of different sides.					
½ Sum	118 32 22	sine	9.94374						
½ S.—p.d. at gr. al.	42 28 10	sine	9.82943						
			2)19.80010					I is less than 90°,—named south if G is less than 90°, north if G is more than 90°.	
½ F	52 36 00	sine	9.90005	Z	61 36 52				
Angle F	105 12 00			F	105 12 00				
True distance	90 57 20	co-sec.	10.00000	G	166 48 52	co-sine	9.98840		
Least alt.	11 33 12	sec.	10.00888			co-tan.	10.68947	sine	9.30163
Greatest alt.	27 32 18			I	78 08 33 N.	tan.	10.67787	sec.	10.68723
Sum	130 02 50			Dec.	19 56 48 N. (at least alt.)				
½ Sum	65 01 25	co-sine	9.62557	K	98 05 21 N.			sine	9.99566
½ Sum—gr. alt.	37 29 07	sine	9.78430					Latitude 74° 48′ N. sine	9.9845[illegible]
			2)19.41881						
½ Z	30 48 26	sine	9.70940						
Angle Z	61 36 52								

To find the Hour.

G	tan.	9.36974
I	sine	9.99063
K	sec.	10.85166
Hour P. M. 7h. 47m. 42s. or A. M.+12h.=16h. 12m. 18s.	tan.	10.21203

Divided by 2 gives the horary distance of the lowest object from the meridian, } 3h. 53m. 51s. or 8h. 06m. 09s.

The sun being at the lowest altitude, his distance from the *upper* meridian was 8h. 6m. 9s. being the hour of the day, and the sun's distance from the lower meridian, or midnight, was 3h. 53m. 51s.

* Both these logarithms may be taken out at the same time when the sine of the angle was found in the computation of the angle Z.

QUESTIONS FOR EXERCISE.

In the following questions the sun's semi-diameter is supposed to be 16′, and the parallax nothing.

1. Being at sea, in latitude by account 39° 28′ N. when the sun's declination was 20° 41′ N. at 11h. 30m. 15s. A. M. per watch, the altitude of the sun's lower limb was observed to be 68° 18′ 45″, and at 12h. 26m. 28s. P. M. was 70° 58′, the height of the eye being 21 feet above the surface of the sea. Required the true latitude of the ship?

Answer, 39° 23′ N.

2. Being at sea in latitude 50° 40′ N. by account, at 10h. 17m. 30s. A. M. per watch, the altitude of the sun's lower limb was observed to be 17° 4¾′ and at 11h. 17m. 30s. was 19° 31¼′, the declination being 20° S. and the height of the eye 21 feet above the sea. Required the latitude in?

Answer, 50° 1′ N.

3. Suppose a ship at sea, in latitude 47° 34′ N. by account, and that at 9h. 55m. 30s. by watch, the altitude of the sun's lower limb was 17° 24′, bearing by compass S. by E. ¼ E. and at 12h. 54m. 10s. the altitude of the same limb was 21° 45½′ the declination being 19° 30′ S. the height of the eye 20 feet above the sea, and the ship's course by compass E. ½ S. at the rate of 7 knots per hour. What was the true latitude?

Answer, 47° 24′ N.

4. At 11h. 28m. 20s. A. M. per watch, the altitude of the sun's lower limb was 28° 18′ the sun bearing S. by W. by compass. At 2h. 58m. 20s. P. M. the altitude of the same limb was 16° 40′, the height of the eye 20 feet, his declination 13° 17′ S. and the latitude by account 47° 50′ N. the ship's course during the elapsed time N. E. with her larboard tacks on board,* sailing at the rate of 6 knots, and making half a point lee-way—what latitude was she in when the last altitude was taken?

Answer, 48° 9′ N.

To find the latitude by one Altitude of the Sun taken near noon, having the time of observation by a well regulated watch.

When the sun does not pass near the zenith, the meridian altitude and the latitude of the place may be accurately determined by observing his altitude when near the meridian, and noting the time by a watch regulated the preceding morning or following evening, by either of the methods given in this work.† To this time by the watch must be applied a correction equal to the difference of longitude made by the ship (turned into time) in the interval between the regulation and the observation near the meridian, by *adding when the place of regulation was to the westward of the place of taking the other observation, otherwise by subtracting*; the sum or difference will be the time of taking the observation, whence the time from noon will be obtained: with which and the observed altitude (corrected for semi-diameter, dip, &c. as usual) the sun's declination (found in Table IV. and corrected for the longitude of the ship) and the latitude by account; the latitude by observation may be found as follows:

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* The larboard side of a ship is the left side, when the observer is aft, looking towards her head, and the starboard is the right side. When a ship is sailing with her larboard tacks on board, the lee-way is allowed to the right hand; but if her starboard tacks are on board, to the left hand.

In calculating the answers to these questions, proportional parts were taken for the seconds; a small difference would be found if the nearest logarithms only were taken.

† The best time for regulating a watch is when the sun bears nearly east or west, and is above 10° from the horizon.

RULE.

Add together the log. co-sine of the latitude by account (Table XXVII.) the log. co-sine of the declination (Table XXVII.) the logarithm in the column of rising (Table XXIII.) corresponding to the time from noon when the observation was taken; reject 20 in the index, the natural number of the remainder being found (in Table XXVI.) and added to the natural sine of the observed altitude (Table XXIV.) the sum will be the natural co-sine of the meridian zenith distance, from which the latitude may be obtained by the common rules.

If the computed latitude differs considerably from the latitude by account, it is best to repeat the operation, using the latitude last found instead of the latitude by account. This method of finding the latitude by a single altitude of the sun, may be applied to any other celestial object.

EXAMPLE I.

Being at sea in latitude 49° 50′ N. by account, when the sun's declination was 20° S. at 11h. 29m. 20s. A. M. per watch, regulated the preceding morning, in a place 20 miles of longitude to the eastward, the sun's correct central altitude was 19° 41′* bearing south. Required the true latitude?

	H. M. S.			
Time per watch......	11 29 20	Latitude 49° 50′	Co-sine	9.80957
20′ in T. by Tab. XXI.	1 20	Declin. 20 0	Co-sine	9.97299
Time of observation..	11 28 0	Time from noon 0h. 32m. 0s.	Log. rising	2.98820
	12			
			Nat. Num. 590 log.	2.77076
Time from noon......	32 0	Central altitude 19° 41′	Sine 33682	
		Mer. zen. dist. 69 57 N.	Co-sine 34272	
		Declination 20 0 S.		
		Latitude ......49 57 N.		

EXAMPLE II.

At sea in the latitude of 60 N. by account, the sun being on the equator, at 0h. 59m. 0s. P. M. per watch, regulated the preceding morning in a place 15 miles in longitude to the westward, the sun's correct central altitude† was 28° 53′ bearing south. Required the latitude?

	H. M. S.			
Time per watch	0 59 0	Latitude 60° N.	Co-sine	9.69897
15′ long. in time	1 0	Declination 0	Co-sine	10.00000
Time from noon	1 0 0	Time from noon 1h. 0m.	Log. rising	3.53243
			Nat. Numb. 1704 Log.	3.23140
		Central altitude......28° 53′	Sine 48303	
		Mer. zenith distance..60 0 N.	Co-sine 50007	
		Declination.......... 0 0		
		Latitude ....60 0 N.		

When the observation is taken a few minutes before or afternoon, the correction to be applied to the altitude, to obtain the meridian altitude, may be found by means of Tables XXXII. XXXIII. the first of which contains the variation of the altitude for one minute from noon, expressed in seconds and tenths—the other contains the square of the minutes and seconds of a minute contained in the top and the side columns. By these tables the correction of the observed altitude may be found by the following rule.

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* The observed altitude of the lower limb being 19° 32′. ☉'s semi-diameter 16′, Dip 4′. Refraction 3′, Parallax too small to be noticed.

† The observed altitude of the sun's lower limb being 28° 43′, ☉'s S. D. 16′, Dip 4′, Refraction 2′. Parallax too small to be noticed.

RULE.

Enter Table XXXII. and find the latitude by account in the side column, and the declination at the top, opposite the former and under the latter will be the change of altitude in seconds and tenths for one minute from noon: then enter Table XXXIII. and find the minutes of the time from noon in the top column, and the seconds in the side column, under the former, and opposite the latter, will be a number which is to be multiplied by the number taken from Table XXXII. and the product will be the sought change of altitude, expressed in seconds and decimals.

In making use of Table XXXII. proportional parts may, if necessary, be taken for the miles of latitude and declination. The numbers in both these tables are expressed in whole numbers and tenths.

EXAMPLE III.

Being at sea in the latitude of 40° N. when the sun's declination was 21° N. at 8′ past noon the sun's correct central altitude* was 70° 58′. Required the meridian altitude and latitude?

In Table XXXII. opposite 40° lat. and under 21° dec. is 4″.3, and the number in Table XXXIII. corresponding to 8′ is 64.0. By multiplying 64.0 by 4″.3, the correction 275″.2 (or 5′ nearly) will be obtained; this quantity added to 70° 58′ will give the meridian altitude 71° 3′, and the latitude deduced therefrom will be 39° 57′ N.

By observing several altitudes of the sun when near the meridian, and noting the times, the meridian altitude may be obtained, by the above method, to a great degree of accuracy; for by using this method, many observations may be taken on the same day, and the mean of the meridian altitudes deduced therefrom will in general be much more correct than that obtained by a single observation, by the usual method. To obtain the correction to be applied to the mean of all the observed altitudes, proceed thus:

Take from Table XXXIII. the number corresponding to each time from noon (the minutes being found at the top and the seconds at the side, the correction being under the former and opposite the latter) and divide the sum of these tabular numbers by the number of observations, the quotient being multiplied by the number taken from Table XXXII. will be the correction to be applied to the mean of the observed altitudes, to obtain the meridian altitude.

EXAMPLE IV.

Being at sea in the latitude of 50° N. by account, when the sun's declination was 22° N. observed with a sextant, the altitudes of the sun's lower limb (bearing nearly south) as in the following table: the correction for semidiameter, dip, refraction, &c. being 12′ additive. Required the meridian altitude and latitude?

Obs. Alt. ☉ L. L.	Time from noon.	Numbers Tab.
61.45	6′ 10″	38 0
61.46	4 15	18 1
61.46	3 2	9 2
61.47	2 10	4 7
Sum 247.04		70 0
Mean 61.46		17 5

The mean of the numbers from Table XXXIII. is 17.5, this multiplied by the number of seconds from Table XXXII. viz. 2″.5, gives the correction 43″.75, or 44″, which added to the mean of the observed altitudes 61° 46′ gives the meridian altitude of the sun's lower limb 61° 46′ 44″ or 61° 47′ nearly, to this add 12′ for semi-diameter, &c. the sum 61° 59′ will be the correct central meridian altitude, whence the latitude was 50° 1′ N.

If the above altitudes had been taken with a circle, the calculation would have been exactly the same, except that each altitude would not have been given, but the sum of all of them 247° 4′ would have been shown by the central index after finishing the observations.

* The observed altitude of the sun's lower limb being 70° 46′, Semi-diameter 16′, Dip 4′, Parallax and Refraction too small to be noticed.

EXAMPLE V.

Having regulated my watch, I found it to be 6′ 2″ too slow for apparent time. I then sailed to the southward and eastward till the ship had made 60′ difference of longitude, and was by account in the latitude of 40° N. the sun's declination being 20° S. The sun being then nearly on the meridian I observed ten altitudes of his lower limb by a circle of reflection and noted the times by the watch as in the following table, and the sum of all the altitudes taken from the circle was 298° 20′.—Required the true latitude, supposing the dip to be 4′ and the semi-diameter 16′?

When it was 12 o'clock by the watch it was 12h. 6m. 2s. apparent time at the place where the watch was regulated, and 12h. 10m. 2s. apparent time at the place where the altitudes were taken to determine the latitude, because the former place was 60′ or 4′ in time to the westward of the latter, consequently the watch was 10m. 2s. too slow for app. time at the place of taking the altitudes for determining the latitude. Hence we may determine the time from noon of taking each observation, as in the second column of the adjoined Table, and find the numbers corresponding in Table XXXIII. the mean of which is 6.97, this multiplied by the number in Table XXXII. corresponding to the latitude 40° N. and declination 20° S. viz. 1″.6 will give 11″.152 or 11″, which is the correction to be added to the mean of the observed altitudes to obtain the meridian altitude.

Time per watch	Time from noon.	Numbers Tab. XXXIII.
11.45.43	4′ 15″	18.1
46.58	3 0	9.0
47.52	2 6	4.4
48.50	1 8	1.3
49.28	0 30	0.2
50.48	0 50	0.7
51.10	1 12	1.4
52.13	2 15	5.1
53. 8	3 10	10.0
54.23	4 25	19.5
	Sum	69.7
	Mean	6.97

Now the sum of all the altitudes 298° 20′, divided by 10, the number of observations gives .... 29° 50′ 0″

Add semi-diameter 16′ and the above correction 11″	+		16	11	
Add parallax found in Table XIV.	+			8	
Subtract dip 4′ and refraction 1′ 39″	—		5	39	
Central Altitude		30	0	40	
Zenith distance		59	59	20	N.
Declination		20	0	0	S.
Latitude		39	59	20	N.

When the meridian altitude of the object is small, the correction of altitude may be found by this method, for 12 or 15 minutes from noon, to a great degree of accuracy; but when the sun passes near the zenith, the time of observation must be proportionally nearer to noon. Thus in Example I. preceding, the time from noon was 32′, and as the numbers in Table XXXIII. are the squares of the number of minutes, it follows, that the number corresponding to 32′ would be the square of 32 or 1024.0. This multiplied by the number 1″.3 of Table XXXII. corresponding to the latitude 50° N. and declination 20° S. will give the correction 1331″.2 or nearly 22′, which added to 19° 41′ will give 20° 3′ for the meridian altitude, or 69° 57′ for the zenith distance, being the same as in that example.

It is very advantageous in this method to observe as many altitudes in the afternoon as before noon, and at nearly the same distances from noon, for in this case a small error in the regulating of the watch will not materially affect the calculation. This will appear evident by supposing, in the preceding example, that the watch was 11′ 2″ too slow, instead of 10′ 2″, by which means the times and numbers will be as in the adjoined Table, and the mean of all the numbers taken from Table XXXIII. will be 8.15, which multiplied by 1″.6 will give 13″ nearly, for the correction instead of 11″, so that in this case an error of one minute in the regulation of the watch would only cause an error of 2 seconds in the meridian altitude.

Times.	In Tab. XXXIII.
3.15	10.6
2. 0	4.0
1. 6	1.2
0. 8	0.0
0.30	0.2
1.50	3.4
2.12	4.8
3.15	10.6
4.10	17.4
5.25	29.3
Sum	81.5
Mean	8.15

But it must be carefully observed that in using this method you must not take the observation more than 2 or 3 minutes from noon when the sun passes within 10° or 12° of the zenith.

TO DETERMINE THE LATITUDE ON SHORE

BY MEANS OF AN ARTIFICIAL HORIZON.

IT frequently happens that the latitude of a place on shore cannot be determined by the usual methods, by a quadrant, sextant or circle, on account of not having an open horizon. In this case it is customary to make use of an artificial horizon formed by the surface of a vessel filled with water, mercury, Barbadoes tar, very clear molasses, or any other fluid of sufficient consistency not to be affected by the wind.* With this apparatus an observation may be taken on shore when the altitude of the object does not exceed 60°, with as much ease as at sea. Thus, if an altitude of the sun was required to be taken, the observer must place the vessel containing the mercury (or other fluid) in a firm position on the ground, and in a few minutes the surface of the liquor will attain a horizontal situation, the observer must then place himself in a situation so as to see the image of the sun formed by the fluid, which image will evidently be depressed as much below the horizon as the sun is elevated above, so that to obtain the double of the sun's altitude it is only necessary for the observer to bring the image of the sun formed by the instrument, down to the image formed by the artificial horizon, and the angle then pointed out by the index will be double of the altitude of the sun, the half of which will be the apparent altitude. If the nearest limbs of the two images are brought in contact, the half of the angle obtained by the instrument will be the altitude of the sun's lower limb, but if the farthest limbs are brought in contact, the half angle will be the altitude of the upper limb. The altitude thus obtained must be corrected for semi-diameter, parallax, and refraction, as usual, but not for dip, because a truly horizontal surface is obtained by means of the artificial horizon.† In this manner the altitude of the sun, or any other bright object, may be obtained when the altitude is less than 60°; at higher altitudes the angle corresponding would be above 120°, which cannot be measured by a sextant on account of the length of the arch, nor by any other instrument of reflection, with a sufficient degree of accuracy. To illustrate this method, we shall here add the following examples.

EXAMPLE I.

The angular distance of the nearest limbs of the two images of the sun was found by the above method to be 68° 10', when the declination was 10° S. and the sun's semi-diameter 16', the sun bearing south of the observer. Required the latitude?

Half of 68° 10' is the obs. alt.	34°	5'
Add semi-diameter		16
	34	21
Subtract refraction		1
True altitude	34	20
Zenith distance	55	40 N.
Declination	10	0 S.
Latitude	45	40 N.

EXAMPLE II.

The angular distance of the farthest limbs of the two images of the sun, when on the meridian, was obtained by the above method, and found to be 34° 0', when the declination was 10° N. and the semi-diameter 16'; the sun bearing north of the observer. Required the latitude?

Half of 34° 0' is the obs. alt.	17°	0'
Subtract semi-diameter		16
	16	44
Refraction sub.		3
True altitude	16	41
Zenith distance	73	19 S.
Declination	10	0 N.
Latitude	63	19 S.

The latitude may be determined on shore by this method to a great degree of accuracy by means of a circle of reflection, by taking several altitudes a few minutes before and after the sun passes the meridian, and estimating the correction to be applied to the altitude by means of Tables XXXII. and XXXIII. Thus, if in the example, page 151, the observations had been taken in this manner, the number of degrees denoted by the circle after taking ten observations, would have been 595° 20', this divided by 20, (twice the number of observations,) will give for the observed altitude 29° 46', and by adding the semi-diameter 16', parallax 8", and the correction found by Tables XXXII. and XXXIII. viz. 11 seconds, and subtracting the refraction 1' 39", the central altitude will be obtained 30° 0' 40" as in the page before mentioned.

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* In case the wind blows fresh, you must use a screen formed of two planes of talc or glass whose surfaces are ground perfectly parallel, and connected together in a frame so as to make an angle of about [illegible] with each other. This frame is to be placed over the box containing the fluid, and the rays of the sun passing through one of the plates, is reflected from the surface of the liquor, and passes through the other plate to the eye of the observer. The use of these plates is to be avoided, when it can possibly be done, on account of the defect of parallelism of the surfaces. This error is generally greatest near the border of the glass, so that it has been recommended to cover the edge of the glass with a paper or some paint, to the distance of [illegible] or ½ inch from the frame. If the surfaces of the glass are perfectly parallel, the observed angle will be the same as if the screen had not been used. If the reflecting fluid is molasses, air bubbles will sometimes rise on the surface by the sun's heat, this may in some measure be avoided by heating the molasses before using it.

† If the instrument has an index error, it must be applied to the observed angle, or the half of [illegible] applied to the [illegible] altitude.

Altitudes may be observed in this manner in taking an azimuth for determining the variation, or for regulating a watch in the manner explained in this work.—Observing in all cases, that the half of the observed angle is to be corrected for refraction, parallax, and semi-diameter, but not for the dip of the horizon; and that half the index error only is to be applied.

TO FIND THE LATITUDE BY AN ALTITUDE OF THE POLAR STAR.

IN northern climates the latitude may be determined by means of an observed altitude of the Polar Star, provided the apparent time of observation can be ascertained within a few minutes.* This method might be frequently used at sea, when the horizon is well defined, if that star were of the first magnitude, but being only of the 2d. or 3d. magnitude, it is sometimes so dim that it is rather difficult to determine the altitude with precision. However, as there are times when it would be of great importance to determine the latitude within 10 or 12 miles, it was thought adviseable to explain this method, which may be used when observations of the sun or moon cannot be obtained.

Having therefore the apparent time of observation (which must be reckoned from noon to noon in numerical succession, that is 6h. A. M. must be called 18h. &c.) and the observed altitude of the star determined by a fore-observation, you must subtract from the altitude the dip, which is in general 4 minutes, and the refraction, and you will obtain the true altitude of the star. Then the sun's right ascension corresponding to the given day, must be found in Table VI.† and added to the apparent time of observation (rejecting 24 hours when the sum exceeds 24 hours) with that sum enter the adjoined table and take out the corresponding correction, which must be added to, or subtracted from the true altitude, according to the directions in the table—the sum or difference will be the latitude of the place of observation.

Find in the side column the sum of the hour of the day and the sun's right ascension, and the number in the middle column will be the correction of the true altitude.

If the hour is found in these columns, the correction is subtractive.		Correction of the altitude.	If the hour is found in these columns, the correction is additive.	
h. m.	h. m.	° ′	h. m.	h. m.
0. 58	0. 58	1. 38	12. 58	12. 58
1. 3	0. 53	1. 38	12. 53	13. 3
1. 13	0. 43	1. 38	12. 43	13. 13
1. 23	0. 33	1. 38	12. 33	13. 23
1. 33	0. 23	1. 37	12. 23	13. 33
1. 43	0. 13	1. 36	12. 13	13. 43
1. 53	0. 3	1. 35	12. 3	13. 53
2. 3	23. 53	1. 34	11. 53	14. 3
2. 13	23. 43	1. 33	11. 43	14. 13
2. 23	23. 33	1. 31	11. 33	14. 23
2. 33	23. 23	1. 30	11. 23	14. 33
2. 43	23. 13	1. 28	11. 13	14. 43
2. 53	23. 3	1. 26	11. 3	14. 53
3. 3	22. 53	1. 24	10. 53	15. 3
3. 13	22. 43	1. 22	10. 43	15. 13
3. 23	22. 33	1. 19	10. 33	15. 23
3. 33	22. 23	1. 16	10. 23	15. 33
3. 43	22. 13	1. 14	10. 13	15. 43
3. 53	22. 3	1. 11	10. 3	15. 53
4. 3	21. 53	1. 8	9. 53	16. 3
4. 13	21. 43	1. 5	9. 43	16. 13
4. 23	21. 33	1. 1	9. 33	16. 23
4. 33	21. 23	0. 58	9. 23	16. 33
4. 43	21. 13	0. 54	9. 13	16. 43
4. 53	21. 3	0. 51	9. 3	16. 53
5. 3	20. 53	0. 47	8. 53	17. 3
5. 13	20. 43	0. 43	8. 43	17. 13
5. 23	20. 33	0. 39	8. 33	17. 23
5. 33	20. 23	0. 36	8. 23	17. 33
5. 43	20. 13	0. 32	8. 13	17. 43
5. 53	20. 3	0. 27	8. 3	17. 53
6. 3	19. 53	0. 23	7. 53	18. 3
6. 13	19. 43	0. 19	7. 43	18. 13
6. 23	19. 33	0. 15	7. 33	18. 23
6. 33	19. 23	0. 11	7. 23	18. 33
6. 43	19. 13	0. 6	7. 13	18. 43
6. 53	19. 3	0. 2	7. 3	18. 53
6. 58	18. 58	0. 0	6. 58	18. 58

* If the star is not far from the meridian, an error of half an hour in the time would not affect the latitude above 1 or 2 miles.

† It is accurate enough to take the numbers given in the table; but in strictness the right ascension ought to be taken from the Nautical Almanac, for the hour of observation, reduced to Greenwich time, by adding or subtracting the longitude turned into time.

In some of the copies of the second edition of this work, the words additive and subtractive were printed in the wrong columns. This table will require a correction after a few years, on account of the variation of declination, and right ascension of the star. It corresponds nearly to the year 1824, for every year after that time you must add one quarter of a minute to the times in the side columns, and decrease the tabular corrections of altitude about $\frac{1}{900}$ part. Thus for the year 1836 the times must be increased 3m. for the 12 years, so that 0h. 58′ must be called 1h. 1m. and all the corrections of altitude must be decreased $\frac{1}{72}$ part, so that 1° 16′ must be 1° 15′ nearly and 0° 39′ must be 0° 38′½ nearly.

EXAMPLE I.

At 6h. 9m. P. M. June 3, 1820, the observed altitude of the Polar Star was 16° 10 the dip 4′. Required the latitude of the place of observation?

☉'s Right As.	4h.	44m.	Observed altitude	16°	10′
Hour of obs.	6	9	Sub. Dip 4′, Refrac. 3′		7
Sum	10	53	True Altitude	16	3
			Correction corresponding add	1	24
			Latitude	17	27 N.

EXAMPLE II.

On the 14th. September, 1820, at 2h. 2m. A. M. the altitude of the Polar Star was 24° 16′, when the dip was 4.′ Required the latitude?

	H.	M.			
			Observed altitude	24°	16′
Hr. of obs. 2h. 3m. A. M. or	14	2	Dip 4′, Ref. 2′, Sub.		6
☉'s Right Asc.	11	28			
			True altitude	24	10
Sum, rejecting 24h.	1	30	Corresponding corr. sub.	1	37
			Latitude	22	33 N.

TO FIND THE TIME AT SEA, AND REGULATE A WATCH.

WE have already noticed the difference between the civil, astronomical and nautical computation of time; but as it is a subject of great importance, it may not be unnecessary again to repeat, that a civil day is reckoned from midnight to midnight, and is divided into 24 hours; the first 12 hours are marked A. M. the latter 12 hours P. M. being reckoned from midnight in numeral succession from 1 to 12, then beginning again at 1 and ending at 12. Astronomers begin their computation at the noon of the civil day, and count the hours in numeral succession from 1 to 24, so that the morning hours are reckoned from 12 to 24. Navigators begin their computation at noon, 12 hours before the commencement of the civil day (and 24 hours before the commencement of the astronomical day) marking their hours from 1 to 12 P. M. and A. M. as in the civil computation.

There are two kinds of time, mean and apparent. *Mean time* is that shewn by a clock regulated to mean solar time. *Apparent time* is that shewn by the sun, estimating the apparent noon to commence at the passage of his centre over the meridian of any place.* There is sometimes a difference of a quarter of an hour between mean and apparent time, owing to the unequal motion of the earth in its orbit, and the inclination of its axis. This difference is called the *equation of time,* and is contained Table IV. A. in page 2 of the Nautical Almanac. It is necessary to take notice of the equation of time in determining the longitude by a time-keeper or by the eclipses of Jupiter's Satellites; but it is not necessary in any other nautical observation, because the calculations of the Nautical Almanac, except the times of the eclipses of Jupiter's Satellites, are adapted to apparent time.

We may obtain the apparent time at sea, when the ship makes no way through the water, by observing an altitude of the sun in the morning, and again in the afternoon, when at the same altitude, and noting the times by a watch; for the middle time between these two observations will be the apparent time of the sun's passage by the meridian; hence the error of the

* There is also another method of computing the time, made use of by astronomers, called *Siderial* time, in which the interval between two successive transits of a fixed star to the meridian is estimated as 24 hours, commencing the day at the time the first point of Aries is on the meridian, so that the hour in siderial time is the same as the right ascension of the meridian.

watch may be found. A small correction is necessary for the variation of the sun's declination during the interval between the observations, and the method of calculating this correction will be given in this work, but this method cannot often be made use of at sea by reason of the motion of the vessel.

The best method of obtaining the apparent time at sea, is by observing, by a fore observation, the altitude of the sun's lower limb when rising or falling fastest, or when bearing nearly E. or W. to this altitude we must add the semi-diameter and parallax, and subtract the dip (or instead of these three corrections add 12′,* which will answer very well for an observation taken on the deck of a common sized vessel;) subtract also the refraction taken from Table XII. and the remainder will be the correct altitude. The ship's latitude must be found at the time of observation by carrying the reckoning forward to that time. The declination must be taken from Table IV. or from the Nautical Almanac, and corrected for the ship's longitude, and the distance of the sun from the meridian by Table V. Then *if the latitude and declination be both north or both south, subtract the declination from 90° and you will have the polar distance; but if one be north and the other south, add the declination to 90° and you will have the polar distance.*

Having thus found the correct altitude, latitude, and polar distance, the apparent time of observation may be found by either of the three following methods, of which the first is the most simple, since it does not require the table of natural sines, all the logarithms being found in Table XXVII. This method is abridged by means of the table of hours affixed to the table of log. sines; in using which you must observe, that if the sine or co-sine of the logarithm sought is marked at the top of the table, the name of hour either A. M. or P. M. is also to be found at the top, and the contrary if the sine or co-sine is marked at the bottom.

To find the apparent time by the sun's altitude.

FIRST METHOD.

Add together the correct altitude of the sun's centre, the latitude and the polar distance; from the half sum subtract the sun's altitude, and note the remainder. Then add together the log. secant of the latitude (this and all the other logs. being found in Table XXVII.) the log. co-secant of the polar dist. (rejecting 10 in each index) the log. co-sine of the half sum, and the log. sine of the remainder, half the sum of these four logarithms being sought for in the column of log. sines, will correspond to the hour of the day in one of the hour columns.

EXAMPLE I.

Suppose that on the 10th of October, 1824, sea account, at 8h. 21m. A. M. per watch, in the latitude of 51° 30′ N. and long. 114° E. from Greenwich by account, the altitude of the sun's lower limb by a fore-observation was 13° 32′, the correction for semi-diameter, parallax and dip 12—Required the apparent time of observation?

By example III. page 111, the declination was 6° 34′ S. this added to 90° gives the polar distance 96° 34′. To the sun's observed altitude 13° 32′, I add 12 miles and subtract the refraction 4′, the remainder is the correct altitude 13° 40′.

* The semi-diameter is in general about 16′, the parallax never exceeds 9″, and the dip is about 4′; and as the two former corrections are additive and the latter subtractive, the effect of all three corrections will not differ materially from 12′ additive.

☉'s cor. alt.	13°	40′		
Lat.	51	30	secant	0.20585
Polar dist.	96	34	co-secant ..	0.00286
Sum..........	161	44		
Half Sum......	80	52	co-sine	9.20067
☉'s Alt.	13	40		
Rem.	67	12	sine	9.96467
				2)19.37405
			sine	9.68702

corresponding to which in the column marked A. M. is .... 8h. 7m. 9s.
Time per watch .... 8h. 21m.

Watch too fast 13 51

Hence the time of taking this observation is Oct. 10, 8h. 7m. 9s. A. M. sea account, or which is the same thing, Oct. 10, 20h. 7m. 9s. reckoning from noon to noon; the time by the Nautical Almanac being October 9d. 20h. 7m. 9s.

EXAMPLE II.

Suppose that on the 10th of May, 1824, sea account, at 5h. 30m. P. M. per watch, in lat. 39° 54′ N. long. by account 17° 30′ E. from Greenwich, the altitude of the sun's lower limb by a fore-observation was 15° 45′, the correction for dip, parallax and semi-diameter being 12 miles, consequently the correct altitude 15° 54′—Required the apparent time of the observation?

By Example IV. page 111, the sun's declination was 17° 28′ N. which subtracted from 90° leaves the polar distance 72° 32′.

☉'s Alt.	15°	54′		
Lat.........	39	54	secant	0.11511
Pol. dist.....	72	32	co-secant	0.02050
Sum	128	20		
½ Sum	64	10	co-sine ...	9.63924
☉'s Alt.	15	54		
Remainder	48	16	sine	9.87288
				2)19.64773
			sine	9.82386

corresponding to which in the column P. M. is 5h. 34m. 26s. the true time of day.
Time per watch 5 30

Watch too slow 4 26

EXAMPLES TO EXERCISE THE LEARNER.

1. In lat. 36° 39′ S. ☉'s declination 9° 27′ N. the altitude of the ☉'s lower limb in the morning was observed 10° 33′.* Required the apparent time?
Answer, 7h. 23m. 51s.

2. In lat. 36° 21′ S. ☉'s declination 8° 44′ N. alt. ☉'s L. L. in morning 10° 48′.* Required the apparent time? Answer, 7h. 22m. 11s.

3. In lat. 29° 25′ N. ☉'s declination 23° 20′ N. observed alt. of ☉'s lower limb in the afternoon 14° 58′.* Required the time? Answer, 5h. 41m.

4. In lat. 3° 31′ S. ☉'s declination 20° 3′ S. observed alt. ☉'s L. L. 38° 41* in the afternoon. Required the time? Answer, 3h. 18m. 47s.

5. In lat. 13° 17′ N. ☉'s declination 22° 10′ S. in the morning observed alt. of ☉'s L. L. 36° 26.* Required the time? Answer, 9h. 17m. 8s.

6. In lat. 21° 36′ S. ☉'s declination 3° 37′ S. in the morning observed altitude of ☉'s L. L. 35° 48′.* Required the time? Answer, 8h. 29m. 50s.

SECOND METHOD.

Find as in the former method, the sun's correct altitude, the ship's latitude, and the polar distance; thence the sun's correct zenith distance and the

* The correction for dip and semi-diameter being 12′ additive, the correction for refraction is also to be applied as usual.

complement of latitude; then *add together the zenith distance, co-latitude, and polar distance, from half their sum subtract the zenith distance, and note the remainder; then add together the log. co-secant of the co-lat. (this and all the other logs. being found in Table XXVII.) the log. co-secant of the polar distance (rejecting 10 in each index) the sine of the half sum and the sine of the remainder, half the sum of these four logarithms being found among the log. co-sines, will correspond in one of the adjoined columns to the time of day.*

The two preceding examples are thus worked by this method.

EXAMPLE I.

	90° 0′				90° 0′		90° 0′
☉'s cor. alt.	13 40			latitude	51 30	☉'s dec.	6 34
Zen. dist.	76 20			co-lat.	38 30	Pol. dist.	96 34
Co-lat.	38 30	co-secant	0.20585				
Pol. dist.	96 34	co-secant	0.00286				
Sum	211 24						
½ Sum	105 42	sine	9.98349				
Zen. dist. ...	76 20						
Rem.	29 22	sine	9.69055				
			2)19.88275				
		co-sine	9.94137				

co-sine 9.94137 corresponding to which in the column A. M. is 8h. 7m. 9s. the time of day, which agrees with the other method.

EXAMPLE II.

	90° 0′				90° 0′		90° 0′
☉'s cor. alt.	15 54			latitude	39 54	☉'s dec.	17 28
Zen. dist.	74 6			co-lat.	50 6	Pol. dist.	72 32
Co-lat.	50 6	co-sec.	0.11511				
Pol. dist.	72 32	co-sec.	0.02050				
Sum	196 44						
½ Sum	98 22	sine	9.99535				
Zen. dist.	74 6						
Remainder	24 16	sine	9.61382				
			2)19.74478				
		co-sine	9.87239				

co-sine 9.87239 corresponding to which in the column P. M. is 5h. 34m. 27s. the time of day, which agrees nearly with the first method.

By the preceding method you may find the beginning or ending of the twilight, by calculating the hour when the sun's zenith distance is 108° (or when the sun is 18° below the horizon) for by observation it has been found that the twilight begins or ends when the sun is at that distance from the zenith.

EXAMPLE.

Required the time of beginning and ending of the twilight, June 23, 1820, at Boston?

Zen. dist.	108° 0′		
Co-lat.	47 37	co-secant	0.13156
Pol. dist.	66 33	co-secant	0.03744
Sum	222 10		
½ Sum	111 5	sine	9.96991
Zen. dist.	108 0		
Remainder	3 5	sine	8.73069
		sum	18.86960
		½ sum co-sine	9.43480

½ sum co-sine 9.43480 which corresponds to 2h. 6m. 20s. A. M. and 9h. 53m. 40s. P. M. Therefore, the first appearance of the twilight in the morning was at 2h. 6m. 20s. and the end of it in the evening at 9h. 53m. 40s.

THIRD METHOD.

If the sun or star's declination, and the latitude be both north or both south, take their difference, but if one be north and the other south, take their sum, and from the natural co-sine of this difference or sum subtract the natural sine of the true altitude (both being found in Table XXIV.) find the log. of their difference (in Table XXVI.) add thereto the log. secant of the latitude (from Table XXVII.) and the log. secant of the sun or star's declination (from the same Table) rejecting 10 in each index; the sum of these three logarithms being found in the column of rising (Table XXIII.) the hours, minutes, and seconds corresponding, will be the apparent time from noon, if an altitude of the sun was taken: but if a star was observed, the corresponding time will be the horary distance of the star from the meridian.

The two preceding examples are thus worked by this third method.

EXAMPLE I.

Latitude	51° 30′ N.			secant	0.20585
Declination	6 34 S.			secant	0.00266
Sum	58 4	Nat. co-sine	52893		
Sun's corr. altitude	13 40	Nat. sine	23627		
		Differ.	29266	log.	4.46636
					4.67507 corresponding to

which in the column of rising is .... 3h. 52m. 51s.

	h.	m.	s.
	12		
Subtracted from 12h. leaves the true time	8	7	9
Time per watch	8	21	
Watch too fast		13	51

agreeing with the former methods.

EXAMPLE II.

Latitude	39° 54′ N.			secant	0.11511
Declination	17 28 N.			secant	0.02050
Difference	22 26	Nat. co-sine	92432		
Corr. altitude	15 54	Nat. sine	27396		
		Difference	65036	log.	4.81315
					4.94876 corresponding to

	h.	m.	s.
which in the column rising is	5h.	34m.	27s.
Time per watch	5	30	
Watch too slow		4	27

agreeing nearly with the other methods.

To find the apparent time by an altitude of a fixed star.

Correct the observed altitude for the dip and refraction (the dip being generally 4 minutes when the observation is taken on the deck of a common sized vessel) find the ship's latitude at the time of observation, and the star's right ascension and declination in Table VIII.* then add together the star's correct altitude, the ship's latitude, and the polar distance; from the half sum subtract the star's altitude, and note the remainder. Then add together the log. secant of the latitude, the log. co-secant of the polar distance, rejecting 10 in each index, the log. co-sine of the half sum, and the log. sine of the remainder, half the sum of these four logarithms will be the log. sine of half the hour angle; take out the corresponding time in the column marked P. M. (Table XXVII.) and apply it to the star's right ascension, by subtracting when the star is east of the meridian, or adding when west of the meridian, the sum or difference will be the right ascension of the meridian. From the right ascension of the meridian (increased by 24 hours if necessary) subtract the sun's right ascension at noon at Greenwich, taken from

* The right ascensions and declinations of the stars in Table VIII. are the mean values for January 1st, 1820, and must be reduced to the time of observation by means of the annual variation given in the same Table. When very great accuracy is required, the right ascension and declination thus obtained, must be corrected for the Aberration and Nutation as explained in the precepts of Tables XLII. XLIII.; but in general these corrections may be neglected. These corrections are however all noticed in the places of 24 of the most noted fixed stars, given in the Nautical Almanac since the year 1822, for every ten days in the year, and when any of these stars are used, the places must be taken out, to the nearest day, from the Nautical Almanac, without any farther correction. Thus in July 29, 1824, Procyon's right ascension was 7h. 30m. 7s. *north* polar distance 84° 19′ 52″ or 5° 40′ 8″ N. declination, corresponding to 35° 40′ 8″ *south* polar distance. This additional Table of the Nautical Almanac simplifies this kind of calculation considerably.

page 2d. of the month in the Nautical Almanac, the remainder will be the approximate time at the ship. To this time apply the longitude of the ship from Greenwich, turned into time, by adding in west longitude or subtracting in east longitude, the sum or difference will be the apparent time of the observation nearly, at the meridian of Greenwich.* Take from the Nautical Almanac the sun's right ascension for the preceding and following noons, and take the difference, which seek for at the top of Table XXXI.† and the hours and minutes of the time at Greenwich in the side column, the corresponding correction being subtracted from the approximate time at the ship, will give the apparent time required.

EXAMPLE I.

Suppose that on September 9, 1820, sea account, in latitude 7° 45′ S. and longitude 30° 18′ E. from Greenwich, the altitude of the star Procyon, being then east of the meridian, was 28° 16′ and the dip 4′. Required the time of observation?

By Table VIII. for the year 1820.

Procyon's right ascension	7h.	29′	52″	Dec.	5° 41′ N.	
Variation in 8½ months			2	Var.	0	
Star's right ascension	7	29	54	Dec.	5 41 N.	
					90	
				Pol. dist.	95 41	

Star's obs. alt.	28°	16′		
Dip		4		
	28	12		
Ref. Table XII.		2		
Correct altitude	28	10		
Latitude	7	45	secant	0.00399
Polar distance	95	41	co-sec.	0.00214
Sum	2)131	36		
½ Sum	65	48	co-sine	9.61270
Alt.	28	10		
Remainder	37	38	sine	9.78576
			sum	2)19.40459

½ sum sine 9.70229 corresponding to which, in the column P. M. is ... 4h. 2m. 2s.

the column P. M. is	4h.	2m.	2s.
Star's right ascension	7	29	54
Right ascension of the meridian	3	27	52
Increased by	24		
	27	27	52
Sept. 9. sea account, is September 8, by N. A. sun's R. A. noon	11	7	20
Approximate time at the ship	16	20	32
Ship's longitude 30° 18′ in time	2	1	12
Time at Greenwich nearly	14	19	20

Sun's right ascension September 8,	11h.	7m.	20s.
September 9,	11	10	56
Daily difference	3	36	

The correction of Table XXXI. corresponding, is 2m. 9s. which being subtracted from the approximate time 16h. 20′ 32″ leaves the apparent time at the ship 16h. 18′ 23″ or 4h. 18′ 23″ A. M.‡

* When the sum exceeds 24 hours, you must subtract 24 hours and add 1 to the day of the month, and when the hours to be subtracted are more than the hours of the time at the ship, you must add 24 hours to the latter, previous to the subtraction, and take 1 day from the day of the month.

† Table XXXI. is only calculated to 12 hours. If the time at Greenwich exceeds 12 hours, you must first take out the correction for 12 hours, and add it to the correction taken out for the rest of the time; the sum will be the sought correction.

‡ If the ship was furnished with a Chronometer regulated to Greenwich time, the ☉'s Right Ascension might have been found at once from the Nautical Almanac to be the sum of 11h. 7m. 20s. and 2m. 9s. equal to 11h. 9m. 29s. which subtracted from 27h. 27m. 52s. gives the apparent time at the ship 16h. 18m. 23s. more simply than by the above method. The same remark will apply to other examples.

EXAMPLE II.

Suppose that on April 16, 1820, sea account, in lat. 48° 57′ N. and long. 66° W. the observed altitude of Aldebaran when west of the meridian was 22° 25′, and the dip 4′. Required the apparent time at the ship?

	H.	M.	S.		
By Table VIII. for the year 1820, R. As. Aldeb.....	4	25	36	Dec.	16° 8′ N.
Variation for 3½ months			1	Var.	0
Star's right asc.	4	25	37	Dec.	16 8 N.
					90
				P. dist.	73 52

Obs. alt. Aldeb....	22°	25′		
Dip		4		
	22	21		
Refraction		2		
Cor. alt. Aldeb. ..	22	19		
Latitude	48	57	secant	0.18262
Pol. dist.	73	52	co-sec.	0.01745
Sum	2)145	8		
½ Sum	72	34	co-sine	9.47654
Alt.	22	19		
Remainder	50	15	sine	9.88584
			sum	2)19.56245
			½ sum sine ..	9.78122 corresponding to which,

	h.	m.	s.
in the column P. M. is	4	57	24
Star's right ascension..........	4	25	37
Right ascen. of the meridian....	9	23	1
April 16, sea account, is April 15, by N. A. when ☉'s rt. asc. noon	1	34	12
Approximate time at ship.......	7	48	49
Long. 66° W. in time	4	24	
App. time at Greenwich.......	12	12	49

Sun's right ascen.	April 15,	1h.	34m.	12s.
	April 16,	1	37	54

Daily difference .... 3 42 the correction of Table XXXI. corresponding, is 1m. 53s. which being subtracted from the approximate time at the ship, 7h. 48′ 49″

leaves the apparent time at the ship 7 46 56 P. M.

This method of obtaining the time by the stars would be accurate if a good horizon could be obtained; but as that is not always the case, it is best to regulate your watch by the sun.

To regulate a watch by equal altitudes of the sun.

A watch may be regulated on shore by observing in the morning and evening the times when the sun is at the same altitude,* for the middle between these times would be the apparent time of noon by the watch if the declination of the sun remained the same during the observation; but if the declination varies, as is generally the case, the apparent time of noon determined in this manner (which for distinction we shall call the *middle time)* must be corrected for the change of declination by an equation, called the *equation of equal altitudes*, and the middle time thus corrected will be the

* The altitudes should be taken when the sun rises or falls fast. The best time for observation is when the bearing of the sun is east or west. In general two or three hours from noon will be sufficient. An artificial horizon, formed by a vessel filled with mercury, may be used in taking these altitudes.

correct time of apparent noon by the watch. For greater accuracy, several altitudes should be taken in the morning, and corresponding ones in the afternoon, and the mean of the times of the morning and evening observations should be respectively taken, and the equation of equal altitudes corresponding to the mean of all the observations calculated and applied to the middle time, as if a single set of observations only had been taken.

In noting the times of observation, you must count the hours in numeral succession, so that if some of the observations are taken before 12h. by the watch, and others after 12h. the next hour to 12h. must be called 13h. the next 14h. &c. Half the sum of the times of observation, corresponding to any set of observations (or the mean of a number of observations) will be the middle time, and the difference of the times of observation will be the elapsed time.

The equation of equal altitudes consists of two parts, which may be calculated by the following rule:

RULE 1.—To the constant log. 8.8239 add the log. co-tangent of the latitude, the log. sine corresponding to the elapsed time found in the column P. M. of Table XXVII. the prop. log. of the hours and minutes of the elapsed time, reckoned as minutes and seconds, and the prop. log. of the daily variation of the sun's declination, the sum, rejecting 30 in the index, will be the prop. log. of the first part of the equation of equal altitudes, reckoning minutes and seconds as seconds and thirds respectively.

2. To the constant log. 8.8239 add the log. co-tangent of the sun's declination, the log. tangent corresponding to the elapsed time found in the column P. M. of Table XXVII. the prop. log. of the hours and minutes of the elapsed time reckoned as minutes and seconds, and the prop. log. of the daily variation of the sun's declination, the sum, rejecting 30 in the index, will be the prop. log. of the *second part* of the equation of equal altitudes, reckoning minutes and seconds as seconds and thirds respectively.

The first part of the equation of equal altitudes is to be added to the middle time when the sun is receding from the elevated pole, otherwise subtracted ;* and the second part is to be added when the declination is increasing, but subtracted when decreasing ;† these two corrections, being applied to the middle time, will give the apparent time of noon by the watch.

EXAMPLE.

Suppose that on the 9th. of May, 1820, civil account, in the latitude of 40° N. and long. 10° W. the following observations were taken at equal altitudes of the sun. Required the error of the watch ?

Alt. ☉'s L. L.		Times per watch. A. M.			Times per watch. P. M.		
15° 35'		6h.	29m.	51s.	17h.	32m.	18s.
15 45		6	31	7	17	31	0
15 55		6	32	14	17	29	54
	Sum		93	12		93	12
	Mean	6	31	4	17	31	4
					6	31	4
	Difference is elapsed time				11	0	0
	Sum				2)24	2	8
	Middle time				12	1	4

Constant log.	8.8239		8.8239
Lat. 40° co-tang................	10.0762	dec. 17.25 cot.	10.5035
Elap. time 11h. Sine............	9.9963	tang.	10.8806
Elap. time 11h. or 11' P. L......	1.2139		1.2139
Vari. Dec. 15' 48''‡ P. L......	1.0566		1.0566
1 part 12'' 15''' P. L......	1.1669	2d. part 0'' 36''' P. L..	2.4785

The first part of this equation 12'' 15''' is subtractive, because the sun is proceeding towards the elevated pole ; and the second part 36''' is additive, because the declination is increasing, so that the whole equation is about 12 seconds subtractive; this applied to the middle time 12h. 1m. 4s. gives the time of apparent noon by the watch 12h. 0m. 52s. so that the watch is 52 seconds too fast for apparent time.

* Thus in north latitudes the first part is to be added from the summer to the winter solstice, and subtracted the rest of the year.

† It is here supposed that the elapsed time is less than 12 hours, which is generally the case, but if that time exceeds 12 hours, the second part must be applied in a contrary manner to the above rule.

‡ On May 9, at noon, by the Nautical Almanac, the declination was 17° 24' 42'', and on the following noon 17° 40' 30'', the difference 15' 48'', being the daily variation. The declination corresponding to the long. of 10° W. being 17° 25' N. nearly.

LUNAR OBSERVATIONS.

ALMOST all the methods of determining the difference of longitude between any two places, depends on the general principle of finding the difference between the times of taking any observation, estimated under the meridian of both those places. For in any place it is reckoned to be noon when the sun is on the meridian, and as the sun, by his diurnal motion, appears on the meridian of Greenwich (from which the longitude is reckoned) one hour earlier than in a place in 15° W. longitude.* and one hour later than in a place in 15° E. longitude, and in proportion for a greater or less longitude, it follows, that if at the time of taking an observation, the corresponding time was known at Greenwich, the longitude of the place of observation would be found by allowing 15° for every hour of difference between those times, the longitude being East when the time at Greenwich is earlier than at the place of observation, otherwise West. Now an observer at any place, may determine the apparent time at any moment, by a watch regulated by any of the preceding methods; and if, at the same moment, the apparent time could be obtained at Greenwich, nothing more would be necessary for determining the longitude. One method of determining the time at Greenwich is by a watch regulated to Greenwich time: for it is evident that if a watch could be so constructed as to go uniformly at all times, and in all places, an observer, furnished with a watch thus regulated, would only have to compare the time at the place of observation with the time at Greenwich shewn by the watch, and the difference of the times would give the difference of longitude. This method is useful in a short run, but in a long voyage, implicit confidence cannot be placed in an instrument of such a delicate construction, and liable to so many accidents. Another method of determining the longitude is by observing the beginning or end of an eclipse of the moon, or the satellites of Jupiter, and taking the difference between the time of observation and the time given in the Nautical Almanac for the meridian of Greenwich; it being evident that such an eclipse must be observed at both places at the same moment of absolute time, consequently the difference of the times will be the difference of longitude. An observation of an eclipse of the sun, or an occultation, after making allowance for parallax, &c. as taught in the Appendix to this work, may be used in like manner, and this is the most accurate method known. However, observations of eclipses are but of small practical utility at sea; for those of the sun and moon happen too seldom, and the difficulty of observing the eclipses of Jupiter's satellites prevents that method from being made use of. Other methods have been proposed, but among them all there is not one of such practical utility, as that by measuring the angular distance of the moon from the sun, or from certain fixed stars situated near the ecliptic, usually called a *Lunar Observation*. For observations of this kind may be taken in fair weather at all times (except near the time of new moon) when the objects are above 8° or 10° above the horizon, and as the moon moves in her orbit about 1′ in 2 minutes of time, it follows that if her angular distance can be ascertained from the sun or star within 1′ the time at Greenwich will be known within 2 minutes, and the longitude within 30 miles. To facilitate this method, there is annually published, by the Commissioners of Longitude in England, a Nautical Almanac, containing the true angular distances of the moon from the sun and certain fixed stars, for the beginning of every third hour, calculated for the meridian of Greenwich, and the time corresponding to any intermediate hour, may be found by proportional parts; hence an observation of these angular distances being taken in any place, and the corresponding time at Greenwich found by the Almanac, and compared with the time at the ship, their difference will be the longitude of the place of observation. But before the observed angular distance is compared with those in the Nautical Almanac, the corrections for parallax and refraction must be applied to obtain the *true distance*; for the moon being seen always lower than her true place, and the sun and stars higher, the true distance is almost always greater or less than the observed distance.

* Because the sun, by his apparent diurnal motion, describes 360 degrees in 24 hours, which makes 15 degrees in an hour.

The angular distances of the moon from the sun and proper stars, are generally given in the Nautical Almanac from one object on each side of her, to afford a greater number of opportunities of observation, and to enable the observer to correct in a great degree, the errors of the instrument, the adjustments, or a faulty habit of observing the contact of the limbs, because these errors have a natural tendency to correct each other, in taking the mean of observations made with stars on different sides of the moon. Previous to taking the observation, the Nautical Almanac must be examined, to see from what objects the distances are computed, and from those objects only must the distances be measured.

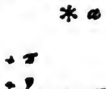
There are only nine stars from which the angular distances are computed in the Nautical Almanac; and as it is of the greatest importance to be able to discover them easily, I shall here add a number of remarks which will be found useful for that purpose.

The best way of discovering any star, is by means of a celestial globe. If that cannot be obtained, the time of the star's passing the meridian, and its meridian altitude, may be calculated, and by observing at that time, the star may be easily discovered. The distances marked in the Nautical Almanac afford also to the observer an easy method of knowing the star from which the moon's distance is to be observed; for he has nothing to do but to set the sextant or circle to the distance computed roughly for the apparent time, estimated nearly for the meridian of Greenwich, and direct his sight to the east or west of the moon, according as the distance at Greenwich was found in the VIII. IX. X. and XI. pages of the month: and having found the reflected image of the moon upon the horizon glass, sweep the instrument to the right or left, and that image will pass over the sought star, if above the horizon, and the weather clear: the star is always one of the brightest, and is situated nearly in a line perpendicular to the moon's horns, or which is the same thing, in the line of the moon's shorter axis produced.

The computed distance made use of in sweeping for the star, may be found in this manner. Reckon the apparent time at the ship in the manner of astronomers (by counting 24 hours from noon to noon, and taking the day one less than the sea account;) to this time apply the longitude turned into time, by adding in west, and subtracting in east longitude; the sum or difference will be the apparent time at Greenwich nearly. Take the distances from the Nautical Almanac for the time immediately preceding and following this estimated time, and note the difference of these distances: Then say as 3h. or 180′ is to the difference of the distances, so is the difference between the apparent time at Greenwich and the next preceding time set down in the Nautical Almanac, to a proportional part to be added to the next preceding distance taken from the Nautical Almanac if the distance be increasing, but subtracted if decreasing; the sum or difference will be the distance at which the quadrant or sextant is to be fixed.

In sweeping for the stars by this method, it will often happen that two or more are swept upon at once; this might cause some difficulty to an inexperienced observer, who would be at a loss to know which to make use of. To remove this, the following description of these stars is added.

α ARIETIS.



This star bears about west, distant 23° from the Pleiades or Seven Stars; it is of the second magnitude, and may be known by means of the star π of the third magnitude, situated S. W. from α Arietis at the distance of 3¼ degrees. South from the star π at the distance of 1½°, is the star ν, of the fourth magnitude. The northernmost of these stars is α Arietis.

ALDEBARAN.

About 35° E. from α Arietis, and 14° S. E. from the Pleiades or Seven Stars, is the bright star Aldebaran. Near this star, to the westward, are six or seven stars of the third or fourth magnitude, forming with Aldebaran a figure resembling the letter V, as is represented in the adjoined figure, where Aldebaran is marked α. At the distance of 23° from this star, in a S. E. direction, are three very bright stars, situated in a straight line near to each other, forming the belt of Orion.

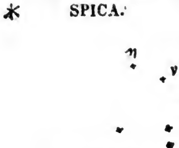
POLLUX.

At the distance of 45° from Aldebaran, in the direction of E. N. E. is the Star Pollux, which is a bright star, though not of the first magnitude. N. W. from it, distant 5°, is the star Castor, of nearly the same magnitude, and you will almost always sweep both at once; the southernmost is the one used.

REGULUS.

E. by S. ½ S. from Pollux, at the distance of 37½°, is the star Regulus, of the first magnitude; to the northward of this star, (at the distance of 8°) is a star of the second magnitude; near to these are five stars of the third magnitude, the whole forming a cluster resembling a sickle, represented in the adjoined figure, Regulus being in the extremity of the handle. A line drawn from the northern polar star, through its pointers, passes about 12° to the eastward of Regulus.

SPICA.

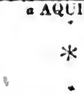


E. S. E. from Regulus, at the distance of 54°, is the star Spica of the first magnitude, with no very bright star near it: S. W. from this star, at the distance of about 16°, are five stars of the third or fourth magnitude, situated as in the adjoined figure; the two northernmost of these stars η, ν, form a straight line with Spica, and by this mark it may be easily discovered. A line drawn from the northern polar star, through the middle star of the tail of the Great Bear, will pass near to Spica.

ANTARES.

E. S. E. from Spica, at the distance of 46°, is the star Antares, in 26 degrees of south declination; it is a remarkable star, of a reddish colour; on each side of it, to the W. N. W. and S. S. E. about 2° distant, is a star of the third or fourth magnitude, no very bright star being near.

α AQUILÆ.

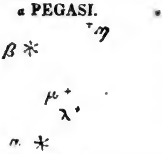


N. E. from Antares, at the distance of 60°, is the very bright star α Aquilæ; N. N. W. from which, at 2° distance, is a star of the third magnitude, and S. S. E. at 3° distance, another star of a lesser magnitude. These three stars appear nearly in a straight line. The star α Aquilæ is nearly of the same colour as Antares.

FOMALHAUT.

S. E. from α Aquilæ, at the distance of 60°, is the star Fomalhaut, which is a bright star of high southern declination, its altitude in northern latitudes being small, never exceeding 20° in the latitude of 40° N. This star bears nearly south from the star α Pegasi, distant 45 degrees. A line drawn from the pointers, through the northern polar star, and continued to the opposite meridian, will pass very near to α Pegasi and Fomalhaut.

α PEGASI.



E. by N. from α Aquilæ, at the distance of 48°, and west from α Arietis, at the distance of 44°, is the star α Pegasi, which may be known by means of four stars of different magnitudes, situated as in the adjoined figure; in which α represents α Pegasi, β a star of the second magnitude, bearing north of it, distant 13°; the others are of lesser magnitude, and two of them, η, μ, form a straight line with the star α Pegasi, and by this mark it may be easily discovered.

It would be a great improvement in the Nautical Almanac if the distances of the moon were also given from the planets Jupiter, Venus, Mars, and Saturn, particularly the two first, as their distances from the moon on account of their brightness, can be measured much more easily than from a fixed star, such observations can be taken during the twilight. These distances have been published, for several years, by Mr. Schumacher, of Copenhagen; also in Baron Zach's Journal.

General observations on the taking of a Lunar Observation.

The accuracy of a lunar observation depends chiefly on the regulation of the watch, and on the exact measurement of the angular distance of the moon from the sun or star; a small error in the observed altitudes of those objects, will not in general much affect the result of the calculation.

The best method of regulating a watch at sea is by taking an altitude of the sun when rising or falling quickly, or when bearing nearly east or west, and noting the time by the watch. With this altitude, the latitude of the place, and the sun's declination, find the apparent time of observation by either of the preceding methods: the difference between this time and that shewn by the watch, will shew how much it is too fast or slow. A single observation taken with care will generally be exact enough; but if greater accuracy is required, the mean of a number of observations may be taken. If the distance of the sun and moon be observed when the sun is three or four points distant from the meridian, the apparent time of observation may be deduced from the altitude of the sun taken at the precise time of measuring the distance; this will render the use of a watch unnecessary, and will prevent any irregularity* in its going, from affecting the result of the observation. If a night observation is to be taken, the watch should be regulated by an altitude of the sun taken the preceding evening, and its going examined by means of another observation taken the next morning; for the time found by an altitude of a star cannot be so well depended upon, except in the morning and evening twilight, as the atmosphere in the night is precarious, and the horizon generally ill defined; but the altitude may be sufficiently exact for finding the correction used in determining the angular distance.

Although all the instruments used in these observations ought to be well adjusted, yet particular care should be taken of the sextant or circle used in measuring the angular distance of the moon from the sun or star, since an error of 1′ in this distance will cause an error of nearly 30′ in the longitude deduced therefrom. When a great angular distance is to be measured, it is absolutely necessary to use a telescope, and the parallelism of it with respect to the plane of the instrument must be carefully examined; but in measuring small distances the use of the telescope is not of such great importance, and a sight tube may then be used, taking care, however, that the eye and point of contact of the objects on the horizon glass be equally distant from the plane of the instrument. But it ought to be observed that it is always conducive to accuracy to use a telescope, and after a little practice it is easily done.

Whilst one person is observing the distance of the objects, two others ought to be observing the altitudes; and the watch either suspended near one of the observers, or put into the hands of a fourth person appointed to note the times; the observer, who takes the angular distance, giving previous notice to the others to be ready with their altitudes by the time he has finished his observation, which being done, the time, altitudes, and distance† should be carefully noted, and other sets of observations taken, which must be done within the space of 15 minutes, and the mean of all these observations must be taken and worked as a single one.

When a ship is close hauled to the wind, with a large sea, or when sailing before the wind, and rolling considerably, it is difficult to measure the distance of the objects; but when the wind is enough upon the quarter to keep the ship steady, there is no difficulty, especially in small distances, which are much more easily measured than large ones, and are not so liable to error from an ill adjustment of the telescope; an observer would therefore do well to choose those times for observation, when the distance of the objects is less than 70° or 80°. An observation of the sun and moon is generally much easier to take when the altitude of the moon is less than that of the sun, because the instrument will be held in a more natural and easy manner. When the moon is near the zenith, the observation is generally difficult to take, and liable to be erroneous, because the observer is forced to place himself in a disagreeable posture. For the same reason, an observation of the moon and

* It is not uncommon to find a difference in the regulation of a watch in the forenoon and afternoon; this difference generally arises from the irregularity in the going of the watch.

† If the distances are measured by a circular instrument, it will not be necessary to note the several distances measured, but only the times and altitudes, as the sum of all the distances measured by the circle will be given by the instrument at the end of the observations, and if the altitudes of the objects are also measured by circular instruments, it will not be necessary to note the several altitudes, but only the times of observation.

a star is generally much easier to take when the star is lower than the moon. This situation of the objects may in most cases be obtained by taking the observation at a proper time of the day. But it must be observed that neither of the objects ought to be at a less altitude than 10°, upon account of the uncertainty of the refraction near the horizon; for the horizontal refraction varies from 33′ to 36′ 40″ only by an alteration of 40° in the thermometer. This alteration might cause an error of two degrees in the longitude.

In taking the altitude of the moon, the round limb, whether it be the upper or lower, must be brought to the horizon. In damp weather it is rather difficult to observe the altitude of the stars, on account of their dimness, particularly α Pegasi and α Arietis. Sometimes they are so dim that they cannot be seen through the holes of the sight vane of a quadrant, particularly if the mirrors are not well silvered; in this case the vane must be turned aside, and the eye held in nearly the same place, or the altitude must be taken by a sextant furnished with a sight tube.

We have here supposed that there were observers enough to measure the altitudes when the distance was observed; but if that is not the case, the altitudes may be estimated by either of the methods which will be hereafter given.

Preparations necessary for working a Lunar Observation.

Find the apparent time of observation by astronomical account, reckoning the hours from noon to noon in numerical succession from 1 to 24, and taking the day one less than the sea account; to this time apply the longitude turned into time by Table XXI.* by adding if in west longitude, but subtracting if in east; the sum or difference† will be the supposed time at Greenwich or *reduced time.*

In page VII. of the month of the Nautical Almanac. find the moon's semi-diameter and horizontal parallax, for the nearest noon and midnight before and after the reduced time, and find the difference of the parallaxes and the difference of the semi-diameters; then enter Table XI. with these differences respectively in the side column, and the reduced time at the top, opposite the former and under the latter, will stand the corrections‡ to be applied respectively to the semi-diameter and horizontal parallax marked first in the Nautical Almanac, additive if increasing, subtractive if decreasing; the sum or difference will be the horizontal semi-diameter and the *horizontal parallax* respectively, at the time of observation. To this horizontal semi-diameter, must be added the augmentation from Table XV. corresponding to the moon's altitude, the sum will be the *true semi-diameter* of the moon.

The sun's true semi-diameter is to be found in page III. of the month of the Nautical Almanac.

To the observed altitude of the sun's or moon's lower limb add 12′, but if the upper limbs were observed, subtract 20′, and from the star's observed altitude subtract 4′, and you will have nearly the *apparent altitudes* of those objects respectively.§

To the *observed distance of the moon from a star*, add the moon's true semi-diameter, if her nearest limb was observed, but subtract that semi-diameter if her farthest limb was observed; the sum or difference will be the *apparent distance.* But to the *observed dis-*

* Or by multiplying by 4 sexagesimally, in the manner directed in the note, page 124.

† When the sum exceeds 24 hours, you must subtract 24 hours and add one to the day of the month; and when the time to be subtracted is greater than the apparent time, the latter must be increased by 24 hours, and one day taken from the day of the month, conformable to the usual rules of addition and subtraction. If the chronometer used in taking the observation be regulated to Greenwich time, this part of the calculation will be unnecessary, because the reduced time at Greenwich will be given directly by the chronometer.

‡ These corrections may be found easily without the table, by saying, as 12 hours are to the reduced time, (rejecting 12 hours when it exceeds 12) so is the difference of semi-diameter or parallax for 12 hours to the corresponding correction. If the reduced time cannot be found accurately in the table, you must use the nearest numbers which will in general be sufficiently accurate.

§ These altitudes are supposed to be taken at sea by a fore-observation; and the application of the above numbers will give the apparent altitudes corresponding to observations taken on the deck of a common sized vessel (where the dip is about 4 or 5′) to a sufficient degree of accuracy: if the observer was 40 or 50 feet above the water, 1′ or 2′ might be taken from these altitudes. The propriety of using these numbers will appear by considering that every wave, by raising the ship above the level of the sea, will alter the dip, and that an error of 1′ or 2′ in the altitudes, will in general cause but a small error in the result of the calculation of a lunar observation, so that for all practical purposes the above numbers may be esteemed as sufficiently exact. It may also be observed, that the error arising from this source will not generally be greater than that arising from neglecting the equations depending on the spheroidal form of the earth, and on the density and temperature of the air; equations which are almost always neglected.

If any one wishes to obtain the apparent altitudes strictly, he must, from the observed altitudes, subtract the dip of the horizon taken from Table XIII. and add or subtract the semi-diameter of the object according as the lower or upper limb was observed.

tance of the sun and moon's nearest limbs, add their true semi-diameters ; the sum will be the *apparent distance*.

These preparations are necessary in every method of working a lunar observation. The most noted methods are those of Dunthorne, Borda, Maskelyne, Rios, Witchell, Lyons, &c. and improvements thereon by various authors.

Dunthorne's and similar methods, have one great advantage, in not being liable to a variety of cases ; but those methods are tedious, when tables of logarithms to minutes only are used, by reason of the great exactness required in proportioning the logarithms to seconds. This is obviated in the excellent methods published by Rios and Stansbury, but they require large and expensive tables, and on that account are not in very general use. Witchell's and Lyon's methods do not labour under the inconvenience of requiring large tables, nor do they require any particular notice of the seconds in finding the log. sines and log. tangents, but these methods are embarrassed with a variety of cases: sometimes the corrections are additive, sometimes subtractive, and learners find a difficulty in rightly applying them. To remedy this, a method was published in the first edition of this work, in which two corrections were constantly additive, two subtractive, and one small correction was additive, when the distance was less than 90°, but subtractive when above 90°.

This method was further improved in the Appendix to that edition, by means of four new Tables, which are inserted in this edition, and numbered XVII. XVIII. XIX. and XX. by means of which the work is considerably shortened, and all the corrections rendered additive. This method will now be given, after making a few remarks on the manner of taking the corrections and logarithms from these new Tables.

Tables XVII. contains a correction and logarithm to be used when the moon's distance from a star is observed, and Table XVIII. is a similar one, to be used when the moon's distance from the sun is observed. Both these Tables are so extended, that no proportional parts are necessary in taking out the corrections and logarithms, except the altitude of the Sun or Star is less than 7° 30′, and at such altitudes an observation is liable to error on account of the uncertainty of the refraction : so that, in using these tables, it is sufficiently accurate to find the number nearest to the given altitude of the sun or star, and make use of the corresponding correction and logarithm. Thus if the star's altitude is 12° 25′, the nearest number in Table XVII. is 12° 24′, corresponding to which are correction 55′ 45″, and logarithm 1.3161.

Table XIX. contains the corrections and logarithms corresponding to the moon's horizontal parallax and altitude, both being found at the same opening of the book. The corrections for seconds of parallax and minutes of altitude, are easily taken out by means of Tables A, B, C, placed in the margin. The method of finding these corrections is given at the bottom of the Table ; they are always additive.

Besides the two logarithms taken from Table XVII. (or XVIII.) and XIX. this new rule requires only four logarithms to be taken from Table XXVII. to four places of figures, and to the nearest minute, it being in general unnecessary to proportion for the seconds.

We shall now give the rule for correcting the distance, and shall, for brevity, use the word sine, secant, and co-secant, instead of log. sine, log. secant, and log. co-secant respectively, and the same will be observed in the second and third methods of correcting the distance.

*Shortest method of correcting the Apparent Distance of the Moon from the Sun.**

Add the apparent distance of the moon from the sun, to their apparent altitudes, and note the *half sum*. The difference between the half sum and the apparent distance, call the *first remainder ;* and the difference between the half sum and the sun's apparent altitude, call the *second remainder*.

Take from Table XXVII. the following logarithms, which mark beneath each other in two columns, viz. the sine of the apparent distance to be marked in both columns, the co-secant of the second remainder to be marked also in both columns, the secant of the first remainder to be placed in the first column, and the secant of the half sum in the second column.†

Enter Table XVIII. (or Table XVII. if a star was used) and take out the correction corresponding to the sun's altitude (or star's :) take also from the same Table the corresponding logarithm, which place in column 1st.

Enter Table XIX. with the moon's apparent altitude and horizontal parallax, find the corresponding correction, which place under the former correction, and the logarithm, which place in column 2d.

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* This rule is the same as that for correcting the distance of the moon from a star, except in reading star for sun, and using Table XVII. instead of Table XVIII. If the distance of the moon from a planet is used, its parallax may generally be neglected, considering it as a fixed star, and using Table XVII. However, if the planet's horizontal parallax is known, the corresponding correction of the distance may be found nearly as follows :

Add together the 1st correction and the cor Tab. XVII. call the sum S. Take the difference between S and 60′ and to its prop. log. add the prop. log. of double of the planet's horizontal parallax, and the arithmetical complement of the log. found in Table XVII. the sum (rejecting 10 in the index) will be the prop. log. of the sought correction, which is to be *added* to the computed distance if S is less than 60′, but *subtracted* if S exceed 60′. See note page 169 for an example of this rule.

† Rejecting always the tens in the indices.

The sum of the four logarithms* of column 1st. will be the proportional logarithm of the first correction, and the sum of the logarithms of column second* will be the proportional logarithm of the second correction; these corrections being found in Table XXII. are to be placed under the former corrections.

Enter Table XX. and seek in the side column the nearest minute of the correction of Table XIX. opposite thereto and under the distance in the column marked Table XIX. will be a number of seconds which reserve. Enter the Table again, and find at the sides the nearest minute to the sum of the correction of Table XIX. and the second correction opposite to this sum and under the distance in the column marked Table XIX. +2d. Cor. will be a number of seconds; the difference between this and the former reserved number of seconds will be a correction to be placed under those already found. Then by adding all these corrections to the apparent distance, decreased by 2°, *the true distance will be obtained nearly.*†

To determine the Longitude from the true distance.

If the true distance of the observed objects can be found in the Nautical Almanac, in either of the pages VIII. IX. X. XI. of the month, opposite to the given day, or to that which immediately precedes or follows it, the time will be found at the top of the page. If the true distance cannot be found in the Nautical Almanac, take out the two distances, one of which is the next greater, and the other the next less, than the true distance; take the difference between these two distances, and also the difference between the distance which stands first in the Nautical Almanac and the true distance. Then the Proportional Logarithm of the former difference (Table XXII.) being subtracted from the prop. log. of the latter difference, the remainder will be the prop. log. of a portion of time to be added to the time standing over the first distance in the Nautical Almanac, and the sum will be the true time at Greenwich. The difference between this time and the apparent time at the ship turned into degrees and minutes by Table XXI. will be the true longitude of the ship from Greenwich at the time of observation, and the longitude will be East if the time at the ship be greater than that at Greenwich, otherwise West.‡

To exemplify the preceding rules there will now be given six examples of correcting the apparent distance by this new rule, in which examples we shall also include the preparation, and the determination of the longitude from the true distance.

EXAMPLE I.

Suppose that on the 2d of January, 1820, sea account, at 6′ past midnight, apparent time in the longitude of 121° 30′ E. by account, the observed distance of the farthest limb of the moon from the star Aldebaran was 47° 48′ 53″, the observed altitude of the star 50° 35′, and the observed altitude of the moon's lower limb 70° 35′. Required the true longitude?

Preparation.

	h.	′
Sea account Jan. 2, is by N. A. Jan. 1d.	12h.	6′
Long. 121° 30′ E. in time	8	6
Reduced time, Jan. 1,	4	0

☽ S. D. Jan. 1, noon	14′ 51″	☽ hor. par. Jan. 1, noon	54′ 25″	✱ obs. alt.	50° 35′
midn.	14 49	midn.	54 17	sub.	4
Difference	2	Difference	8	✱ app. alt.	50 31
Table XI.	1	Table XI.	3	☽ obs. alt. L.L.	70° 35′
Difference	14 50	☽ hor. par.	54 22	add	12
Aug. Tab. XV.	15			☽ app. alt.	70 47
☽ S. D.	15 5	Obs. Dist. ✱		☽ F. L.	47° 48′ 53″
				☽ S. D. sub.	15 5
		App. Dist. ✱		☽	47 33 48

* Rejecting always the tens in the indices.

† The distance obtained by this rule is not perfectly correct, since several small corrections must be applied to obtain the true distance to the nearest second, viz. (1) The refraction taken from Table XII. which was made use of in constructing Tables XVII. XVIII. and XIX. ought to be corrected for the different heights of the Barometer and Thermometer, as directed in page 108. (2) A correction must be applied for the spheroidal figure of the earth. And (3) a very small correction equal to the fourth correction of Witchell's method, given in page 62 of the Appendix of the second edition of the Requisite Tables of Maskelyne, must also be applied.—But to notice all these corrections would increase the calculation very much, and the result of a single observation, in which all these things were noticed, would probably not be so accurate as the mean of two or three observations, taken at different times of the day, in which these corrections were neglected, and the time necessary to take and work the latter observations would not be much greater than to work a single observation, in which all the corrections were noticed.

‡ It may be necessary to observe, that if the times at the ship and Greenwich fall on different days, the latest day is to be reckoned the greatest, though the hour of the day may be the least; thus 17th day 1 hour is to be esteemed greater than 16th day 22 hours.

To find the true distance.

	° ′	Col. 1st.		Col. 2d.			° ′ ″
App. Dist.	47 34	sine	9.8631	same	9.8681	App. Dist. less 2=45	33 49
✱ App. Alt.	50 31	2 Rem. 33° 55′ co-se	0.2534	same	0.2584	Table XVII.	59 14
☽ App. Alt.	70 47	1 Rem. 36 52 sec.	0.0969	½ sum 84° 26′ sec.	1.0152	Table XIX.†	42 08
		Table XVII. log.	1.8676	Table XIX. log.*	.2269	Cor. 1.	1 29
Sum	168 52					Cor. 2.	7 50
		1 Cor. 1′ 29″ P. L.	2.0860	2 Cor. 7′ 50″ P. L.	1.3816	Table XX.	20
½ Sum	84 26						
App. Dist.	47 34					True distance‡	47 24 49
1st. Rem.	36 52						
½ Sum	84 26						
✱ App. Alt.	50 31						
2d Rem.	33 55						

To find the longitude.

	° ′ ″	
True distance	47 24 49	
Dist. by N. A. at 3h.	46 56 11	
Difference	28 38	P. L. 7981
Dist. by N. A. at 3h.	46 56 11	
at 6h.	48 23 59	
Difference	1 27 48	P. L. 3118
	0 58 42	P. L. 4866
add	3	
Time at Greenwich.............	3 58 42	
Time at ship	12 6	
Longitude in time	8 7 18=121° 49′ E. from Greenwich.	

EXAMPLE II.

Suppose that on the 20th September, 1820, sea account, at 7h. 28′ 45″. P. M. apparent time, in the longitude of 166° 30′ W. by account, the observed distance of the nearest limb of the moon from the star Antares was 81° 8′ 18″, the observed altitude of the star 12° 34′, and the observed altitude of the moon's lower limb 20° 26′. Required the true longitude?

Preparation.

Sea account Sept. 20, is by the N. A. Sept. 19d. 7h. 28′ 45″.
Long. 166° 30′ W. in time 11 6

Reduced time Sept. 19 18 29 45

	′ ″		′ ″		° ′ ″
				✱ obs. alt.	12 34
				sub.	4
☽ S. D. Sept. 19, midn.	16 35	☽ hor. par. Sept. 19, midn.	60 47	✱ app. alt.	12 30
Sept. 20, noon	16 40	Sept. 20, noon	61 3	☽ obs. alt. L. L.	20 26
Difference	5	Difference	16	add	12
Table XI.	3	Table XI.	9	☽ App. Alt.	20 38
Sum	16 38	☽ hor. par.	60 56	Obs. Dist. ☽ ✱ N. L.	81 08 18
Aug. Table XV.	5			☽ S. D.	16 43
☽ S. D.	16 43			App. Dist. ☽ ✱	81 20 1

* This Log.=Log. Table XIX. 2260+Log. Table C 9=2269.

† This Corr.=Corr. Table XIX. 41′ 49″+Corr. Table A 13″+Corr. Table B 6″=42′ 08″.

‡ If in this case the object, instead of being the fixed star Antares, had been a planet, whose horizontal parallax is 20″, the correction of distance arising from this parallax, might be found by the rule in the note page 167. Thus, the sum of the Corr. Tab. XVII. (59′ 14″) and Cor. 1 (1′ 29″) is S=60′ 43″. Rejecting 60′ the prop. log. of the remainder 0′ 43″ is 2.4000, the prop. log. of the double horizontal par. 40″ is 2.4314. The arith. comp. log. Table XVII. is 8.1324. The sum of these three logs. (rejecting 10 in the index) is 2.9638 equal to the prop. log. of 12″ the required correction, *subtractive* from 47° 24′ 49″ above found, because S exceeds 60′ and it would therefore become 47° 24′ 37.″

To find the true distance.

	°	′								
App. Dist.	81	20	sine		9.9950	same	9.9350	App. Dist. less 2°	=79° 20′ 01″
✱ App. Alt.	12	30	2 Rem. 44° 44′	Co-se	0.1525	same	0.1525	Table XVII.	55 47
☽ App. Alt.	20	38	1 Rem. 24 06	Sec.	0.0396	½ sum 57° 14′ Sec.	0.2666	Table XIX.†	5 03
			Table XVII.	Log.	1.3194	Table XIX. Log.*	.1888	Cor. 1	5 36
Sum	114	28						Cor. 2	44 55
½ Sum	57	14	1 Cor. 5′ 36″	P. L.	1.5065	2 Cor. 44′ 55″ P. L.	6029	Table XX.	23
1 Rem.	24	6							
2 Rem.	44	44						True distance	81 11 51

To find the longitude.

	° ′ ″		
True distance	81 11 51		
Dist. by N. A. at 18h.	80 57 28		
Difference	14 23	P. L.	1.0974.
Dist. by N. A. at 18h.	80 57 28		
at 21h.	82 50 17		
Difference	1 52 49	P. L.	2029
	0 22 57	P. L.	8945
Add	18		
Time at Greenwich	18 22 57		
Time at ship	7 23 45		
Longitude in time	10 59 12=164° 48′ W.		

EXAMPLE III.

Suppose on April 25th 1820, at 2h. A. M. sea account, in the longitude of 166° E. by account, the observed distance of the moon's farthest limb from Antares was 76° 32′ 15″, the observed altitude of the star 23° 34′, the observed altitude of the moon's lower limb 17° 59′. Required the true longitude?

Preparation.

Sea account April 25, or by N. A. April 24th	14h.	0′
Long. 166° E.	11	4
Reduced time April 24th	2	56

	′	″		′	″			
☽'s S. D. April 24, noon	14′	51″	☽'s Hor. Par. noon	54′	23″	✱ Obs. Alt.	23°	34′
midn.	14	53	midn.	54	31	sub.		4
Difference		2	Difference		8	✱ App. Alt.	23	30
Table XI.		0	Table XI.		2	☽ Obs. Alt. L. L.	17	59
						add		12
Sum	14	51	☽ Hor. Par.	54	25	☽ App. Alt.	18	11
Aug. Tab. XV.		5						
Sub. ☽ S. D.	14	56				Obs. Dist.	76°	32′ 15″
						Sub. ☽ S. D.		14 56
						App. Dist.	76	17 59

To find the true distance.

	°	′	Col. 1st.		Col. 2d.			° ′ ″
App. Dist.	76	17	sine	9.9874	same	9.9874	App. Dist. less 2°	=74 17 19
✱ Ap. Alt.	23	30	2 Rem. 35° 29′ co-se	0.2362	same	0.2362	Table XVII.	57 50
☽ Ap. Alt.	18	11	1 Rem. 17° 18′ sec.	0.0201	½ sum 58° 59′ sec.	0.2879	Table XIX.§	10 51
			Table XVII. log.	1.5794	Table XIX. log.‡	2432	1 Cor.	2 42
Sum	117	58					2 Cor.	31 40
½ Sum	58	59	1 Cor. 2′ 42″ P. L.	1.8231	2 Cor. 31′ 40″ P. L.	0.7547	Table XX.	23
1 Rem.	17	18						
2 Rem.	35	29					True distance	76 00 45

* This Log.=Log. Table XIX. 1883+Corr. Table C 5 =1888.

† This Corr.=Corr. Table XIX. 5′ 5″+Corr. Table A 2″+Corr. Table B 2″=5′ 9″.

‡ This Log.=Log. Table XIX. 2426+Corr. Tab. C 6=2432.

§ This Corr.=Corr. Table XIX. 10′ 19″+Corr. Tab. A 32″+Corr. Tab. B 0″=10′ 51″.

To find the true longitude.

True distance	76° 00′ 45″	Difference 0° 0′ 12″	P. L. 2.9542
By N. A. distance at 3h.	76 00 57	Difference 1 29 59	P. L. 3011
6h.	74 30 58		
		0h. 0′ 24″	P. L. 2.6531
	add	3	

Time at Greenwich 3 0 24
Time at Ship 14
Difference is long. in time 10 59 36=164° 54′ E. from Greenwich.

EXAMPLE IV.

Suppose that on the 31st October, 1820, sea account, at about 1h. P. M. in the longitude of 75° W. by account, the following observations of the sun and moon were taken. Required the true longitude?

Preparation.

Time per watch.	Observed distance. ☉ ☾ N. L.	Observed Alt. ☉ L. L.	Observed Alt. ☽ L. L.
0h. 58′ 5″	68° 43′ 49″	45° 57′	17° 18′
0 59 8	43 18	52	17 9
1 0 10	42 47	48	16 59
1 1 4	42 20	44	16 48
1 1 53	41 56	39	16 36
5) 5 0 20	14 10	240	84 50
1 0 4	68 42 50	45 48	16 58
	☉ S. D. 16 9		
App. time	☽ S. D. 14 53	add 12	add 12
	69 13 52	46 0	17 10
	App. Dist.	App. Alt. ☉	App. Alt. ☽

Sea account 31 Oct. or N. A. Oct. 30d. 1h. 0′ 4″
Long. 75° W. 5

Reduced time Oct. . . . . 30d. 6h. nearly.

☽ S. D. Oct. 30, noon	14′ 50″	☽ Hor. Par. Oct. 30, noon	54′ 21″
midnight..	14 48	midn.	54 13
Difference	2	Difference	8
Table XI.	1	Table XI.	4
	14 49	☽ Hor. Par.	54 17
Aug. Table XV.	4		
☽ S. D.	14 53		

To find the true distance.

App. Dist.	69° 14′	sine	9.9708	same	9.9708	App. Dist. less 2°=67	15 [illegible]
☉ Ap. Alt.	46 0	2 Rem. 20° 12′ co s.	0.4618	same	0.4618	Table XVIII.	59 11
☽ Ap. Alt.	17 10	1 Rem. 3 2 sec.	0.0006	½ sum 66 12 sec.	0.3941	Table XIX.†	10 52
		Table XVIII. log.	1.8848	Table XIX. log.*	2457	1 Cor.	52
Sum	132 24					2 Cor.	15 14
½ Sum	66 12	1 Cor. 52″ P. L.	2.3180	2 Cor. 15′ 14″ P. L.	1.0724	Table XX.	22
1 Rem.	3 2						
2 Rem.	20 12					True distance	68 40 23

* This Log.=Log. Tab. XIX. 2454+Cor. Tab. C 3=2457.

† This Corr.=Corr. Tab. XIX. 10′ 12″+Corr. Tab. A 40″+Corr. Tab. B 0″=10′ 52″.

To find the true longitude.

True distance	68°	40′	23″	Difference	0°	0′	6″	P. L.	3.2553
By N. A. Dist. at 6h.	68	40	29	Difference	1	21	18	P. L.	3452
By N. A. Dist. at 9h.	67	19	11						
					0h.	0′	13″	P. L.	2.9101
				add	6				

Time at Greenwich	6	0	13
Time at Ship	1	0	4
Difference is long. in time	5	0	9 = 75° 2′ W. from Greenwich.

EXAMPLE V.

Suppose that on the 5th May, 1820, sea account, at about 4h. 4′ P. M. in the latitude of 30° 1′ S. and in the longitude of 1° E. by account, the following observations of the sun and moon were taken. Required the true longitude?

Preparation.

	Observed Dist. ☉ ☽ N. L.	Observed Alt. ☉ L. L.	Observed Alt. ☽'s U. L.
	101° 42′ 35″	14° 53′	41° 58′
	41 30	15 21	34
	40 22	15 49	4
Sun's	3) 124 27	46 3	96
Mean	101 41 29	15 21	41 32
Index errors	— 3	— 3	+ 8
Cor. Index errors	101 41 26	15 18	41 40
	☉ S. D. 15 52	add 12	sub. 20
	☽ S. D. 16 14		
	102 13 32 App. Dist.	15 30 ☉ App. Alt.	41 20 ☽ App. Alt.

Sea account, May 5, or N. A. May	4d. 4h. 4′
Longitude 1° E.	4
Reduced time	May 4d. 4h.

☽ S. D. May 4, noon	16′ 3″		☽ Hor. Par. noon	58′ 48″
midnight	16 6		midnight	58 58
Difference	3		Difference	10
Table XI.	1		Table XI.	3
	16 4		☽ Hor. Par.	58 51
Aug. Table XV.	10			
☽ S. D.	16 14			

To find the true distance.

App. Dist.	102° 14′	sine	9.9900	same	9.9900	Ap. Dis. less 100°	13′ 52″
☉ App. Alt.	15 30	2 Rem. 64° 2′ co-se.	0.0462	same	0.0462	Table XVIII.	56 45
☽ App. Alt.	41 20	1 Rem. 22 42 sec.	0.0850	½ sum 79° 32′ sec.	0.7407	Table XIX.	16 35
		Table XVIII. log.	1.4267	Table XIX. log.	1951	1st. Cor.	5 43
Sum	159 4					2d. Cor.	19 12
½ Sum	79 32	1 Cor. 5′ 43″ P. L.	1.4578	2 Cor. 19′ 12″ P. L.	.9720	Table XX.	16
1st. Rem.	22 42						
2d. Rem.	64 2					True distance	101 52 8

To find the apparent time and true longitude.

☉ Correct Altitude*	15°	27′			True distance	101°	52′	3″		
Lat. of Ship	30	1	secant	0.06254	By N. A. dist. at 3h.	102	25	6		
Polar Distance†	106	4	co-secant	0.01730						
Sum	151	32			Difference		33	3	P. L.	7361
					By N. A. dist. at 3h.	102	25	6		
Half Sum	75	46	co-sine	9.39071	6h	100	47	39		
Half Sum—Altitude	60	19	sine	9.93891						
					Difference	1	37	27	P. L.	2665
Sum				2)19.40946		1h.	1′	3″	P. L.	4696
Apparent time 4h. 3′ 32″			sine	9.70473	add	3				
					Time at Greenwich	4	1	3		
					Time at Ship	4	3	32		
					Longitude in time		2	29=0° 37′ E. from Greenwich.		

EXAMPLE VI.

Suppose that on the 8th of February, 1820, sea account, at about 8h. 36′ A. M. in the longitude of 21° W. from Greenwich by account, six distances of the sun and moon's nearest limbs were observed by a circle of reflection to be 464° 10′ 12″ the corresponding times and altitudes being as in the following Table. Required the true longitude?

Preparation.

Apparent time per watch, A. M.	Observed distance ☉ ☾ N. L.	Observed Alt. ☉ L. L.	Observed Alt. ☽ U. L.
8h. 33′ 24″	Sum of the dis-	34° 1′	61° 47′
34 36	tances taken	34 13	61 35
35 18	from the cir-	34 21	61 27
36 36	cle at the end	34 31	61 17
37 4	of the obser-	34 39	61 9
39 2	vations.	35 3	60 45
6) 36 0	464° 10′ 12″	206 48	368 0
8 36 0 App. time	77 21 42 ☉ S. D. 16 14 ☽ S. D. 15 56	34 28 add 12	61 20 sub. 20
	77 53 52 App. Dist.	34 40 ☉ App. Alt.	61 0 ☽ App. Alt.

Feb. 8, sea account, or by N. A. Feb.	7d. 20h.	36′
Long. 21° W.	1	24
Reduced time Feb.	7d. 22h.	

☽'s S. D. Feb. 7, midnight	15′	36″	☽'s Hor. Par. Feb. 7, midnight	57′	9″
Feb. 8, noon	15	43	Feb. 8, noon	57	37
Difference		7	Difference		28
Table XI.		6	Table XI.		23
	15	42	☽'s Hor. Par.	57	32
Aug. Tab. XV.		14			
☽'s S. D.	15	56			

To find the true distance.

App. Dist.	77°	54′	sine	9.9902	same	9.9902	Ap. Dist. less 2°=75°	53′	52″
☉ Ap. Alt.	34	40	2 Rem. 82° 7′ co-se.	0.1028	same	0.1028	Table XVIII.	58	44
☽ Ap. Alt.	61	0	1 Rem. 8 53 sec.	0.0052	½ sum 86° 47′ sec.	1.2509	Table XIX.§	32	20
			Tab. XVIII. Log.	1.7702	Table XIX Log.‡	2025	1st. Cor.	2	26
Sum	173	34					2d. Cor.	5	7
½ Sum	86	47	1 Cor. 2′ 26″ P. L.	1.8684	2 Cor. 5′ 7″ P. L.	1.5464	Table XX.		13
1st. Rem.	8	53							
2d. Rem.	82	7					True distance	77 32	47

* The correct altitude is found by subtracting the refraction 3′ from the apparent altitude 15° 30′.

† The Polar Distance is found by adding the Declination 16° 4′ N. (corresponding to the reduced time) to 90°.

‡ This log.=Log. Table XIX. 2016+Log. Tab. C 9=2025.

§ This Corr.=Corr. Table XIX. 32′ 7″+Corr. Tab. A 13″+Corr. Tab. B 0″=32′ 20″.

To find the true longitude.

True distance	77°	32′	47″	Difference	0°	30′	54″	P. L.	7653
By N. A Dist. Feb. 7, 21h.	78	3	41	Difference	1	32	9	P. L.	2908
Feb. 8, 0h.	76	31	32						
					1h.	0′	22″	P. L.	4745
				add	21				

Time at Greenwich	22	0	22
Time at Ship	20	36	
Diff. is Long. in time	1	24	22=21° 5′ W. from Greenwich.

Second method of finding the true distance of the Moon from the Sun or a Star.

From the sun's refraction (Table XII.) take his parallax in altitude (Table XIV.) the remainder will be the correction of the sun's altitude.

The star's refraction (Table XII.) is the correction of its altitude.

From the proportional logarithm of the moon's Horizontal Parallax* increasing the index by 10, take the sine of the moon's apparent zenith distance (Table XXVII.) the remainder will be the prop. log. of the parallax in altitude, which must be found in Table XXII. and the moon's refraction (Table XII.) subtracted therefrom, the remainder will be the correction of the moon's altitude.†

Add together the apparent distance of the sun and moon (or star and moon) and their apparent zenith distances (or complement of their apparent altitudes) and note the *half sum* of these numbers: the difference between the half sum and the moon's apparent zenith distance call the *first remainder*; and the difference between the half sum and the sun's (or star's) apparent zenith distance call the *second remainder*.

To the constant log. 9.6990 add the co-secant of the half sum and the sine of the apparent distance (both taken from Table XXVII.) the sum, rejecting 20 from the index, will be a *reserved logarithm*.

To the reserved logarithm add the sine of the sun's (or star's) apparent zenith distance, the co-secant of the first remainder (both taken from Table XXVII.) and the prop. log. of the correction of the sun's (or star's) altitude (Table XXII.) the sum, rejecting 30 from the index, will be the prop. log. of the *first correction* to be found in Table XXII.

To the reserved logarithm add the sine of the moon's apparent zenith distance‡ the co-secant of the second remainder (Table XXVII.) and the prop. log. of the correction of the moon's altitude (Table XXII.) the sum, rejecting 30 from the index, will be the prop. log. of the *second correction*, to be found in Table XXII.

Then to the apparent distance add the correction of the moon's altitude, and the first correction, and subtract the sum of the second correction and the correction of the sun's altitude, the remainder will be the corrected distance.

Add 60′ to the correction of the moon's altitude, and 60′ to the difference between the correction of the moon's altitude and the second correction; find both these sums in the side column of Table XX. and in either of the vertical columns, under the corrected distance, find the seconds corresponding,§ the difference of these two numbers will be a number of seconds to be added to the corrected distance when less than 90°, but subtracted when above 90°, the sum or difference will be the true distance.

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* Instead of finding the moon's horizontal parallax from the Nautical Almanac, we may find the proportional logarithm thereof in the same page of the month of that work. Thus if we would work Example III. preceding, by this rule, we might take out the logs. 5198 and 5187, instead of the Hor. Par. 54′ 23″ and 54′ 31″, and obtain by means of Table XI. the sought log. 5195 without referring to Table XXII.

† All these corrections may be found by means of Tables XVII. XVIII. and XIX. Thus the correction of Table XVII. subtracted from 60 minutes, will give the correction of the star's altitude. The correction of Table XVIII. subtracted from 60 minutes, will give the correction of the sun's altitude. The correction of Table XIX. subtracted from 59′ 42″ will give the correction of the moon's altitude. Perhaps the use of these Tables in this and in the following method, would not be inconvenient.

‡ This logarithm was found before, in calculating the correction of the moon's altitude.

§ Observing to take both numbers from the same vertical column. It may be observed that the numbers in one of the columns of Table XX. of this collection, are the same as those of Table XIX. of edition 1, and the numbers in the other column differ 18″ from the former; but the numbers in the side column of Table XIX. differ 60′ from those in Table XX. so that in using Table XIX. edition 1st. it is unnecessary to add 60′ to the correction of the moon's altitude and the first correction; this renders that Table rather more convenient in this second method, than Table XX. of this collection.

EXAMPLE—(*the same as Example I. preceding.*)

Suppose the apparent distance of the centre of the moon from the star Aldebaran was 47° 33′ 48″, the apparent altitude of the star 50° 31′, the apparent altitude of the moon's centre 70° 47′, and the proportional logarithm of the moon's horizontal parallax 5199. Required the true distance of the moon from the star?

	90°	0′		90°	0′	Hor. Par. P. Log.	10.5199	
☽ App. Alt.	70	47	✱ Ap. Alt.	50	31	☽ Z. D. 19° 13′ sine	9.5174	✱ Refrac. 47″
☽ Zen. Dist.	19	13	✱ Zen. Dist.	39	29	17′ 54″ P. L.	1.0025	
						☽ Refraction	20	
						Cor. ☽ Alt.	17 34	

App. Dist.	47°	34′	Constant log.	9.6990		
☽ Zen. Dist.	19	13	½ Sum 53° 8′ co-sec.	10.0969		
✱ Zen. Dist.	39	29	Dist. 47 34 sine	9.8681		
Sum	106	16	Reserved Log.	9.6640	Reserved Log. . .	9.6640
½ Sum	53	8	✱ Zen. Dist. 39° 29′ sine . .	9.8034	☽ Zen. Dist. 19° 13′ sine	9.5174
☽ Zen. Dist.	19	13	1 Rem. 33 55 co-sec.	0.2534	2d. Rem. 13 39 co-sec.	0.6271
1st. Rem.	33	55	✱ Cor. 0′ 47″ P. L.	2.3613	☽ Cor. 17′ 34″ P. L.	1.0106
Half sum	53	8	1 Cor. 1 29 P. L.	2.0821	2d. Cor. 27 18 P. L.	0.8191
✱ Zen. Dist.	39	29				
2d. Rem.	13	39				

Apparent distance	47°	33′	48″	
Add { First Correction . .		1	29	
Add { Cor. ☽ Alt. . . .		17	34	
	47	52	51	
Sub. { 2d. Cor. 27′ 18″ } { Cor. ✱ Alt. 47 } .		28	5	
Corrected distance . .	47	24	46	
Correction Table XX. .			1	
True distance . . .	47	24	47	differing 2″ from the former method.

We shall now give a third method of correcting the apparent distance, being an improvement on Witchell's method, which was published in the former edition of this work. This improvement was made in consequence of a suggestion from a gentleman eminently distinguished for his mathematical acquirements,* that, by a small variation in the calculation, the number of cases might be lessened: and, upon examination, it was found that by making other alterations, the number of cases might be farther decreased, and the manner of applying the corrections rendered more simple. The method thus improved is as follows.

Third method of finding the true distance of the Moon from the Sun or Star.

From the sun's refraction (Table XII.) take his parallax in altitude (Table XIV.) the remainder will be the correction of the sun's altitude.

The star's refraction is the correction of its altitude.

From the proportional logarithm of the moon's horizontal parallax, increasing the index by 10, take the co-sine of the moon's apparent altitude (Table XXVII.) the remainder will be the proportional logarithm of the moon's parallax in altitude; from which, subtracting the moon's refraction (Table XII.) the remainder will be the correction of the moon's altitude.†

1. Add together the apparent altitudes of the moon and sun (or star) and take the half sum; subtract the lesser altitude from the greater, and take the half difference; then add together

The tangent of the half sum,

The co-tangent of the half difference,

The tangent of half the apparent distance.

The sum, rejecting 20 in the index, will be the tangent of the angle A, which must be sought for in Table XXVII. and taken out less than 90° when the sun's altitude is less than the moon's, otherwise greater than 90°.‡ The *difference* of the angle A,

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* The late Chief Justice Parsons.

† These corrections may be found by Tables XVII. XVIII. XIX. as was shown in the note to the second method, page 174.

‡ Every co-tangent in Table XXVII. corresponds to two angles, one greater than 90°, the other less.

and half the apparent distance, is to be called the *first angle*, and their *sum* the *second angle*.

2. Add together the tangent of the first angle.
The co-tangent of the sun or star's apparent altitude.
The prop. log. of the correction of the sun or star's altitude.
The sum, rejecting 20 in the index, will be the prop. log. of the *first correction*.

Or the refraction (Table XII.) corresponding to the first angle or its supplement, will be the first correction nearly; particularly if the altitude of the sun or star be great, and the first angle be near 90°.

3. Add together, the tangent of the second angle,
The co-tangent of the moon's apparent altitude,
The prop. log. of the correction of the moon's altitude,
The sum, rejecting 20 in the index, will be the prop. log. of the second correction.

4. The first correction is to be added to the apparent distance when the first angle is less than 90°, otherwise subtracted; and in the same manner the second correction is to be added when the second angle is less than 90°, otherwise subtracted. By applying these two corrections, we shall obtain the corrected distance or *third angle*.

5. Add 60′ to the correction of the moon's altitude and to the second correction; find both these numbers in the side column of Table XX. and in either of the vertical columns,* under the third angle, find the numbers corresponding; the difference of these two numbers will be a number of seconds to be added to the third angle when less than 90°, but subtracted when above 90°, the sum or difference will be the true distance.

Thus it appears that the first, second and third corrections, depend on the first, second and third angles respectively; *if either of those angles be less than* 90° *the corresponding correction will be additive: but if more than* 90°, *subtractive*. This rule being uniform for applying all three corrections, makes it more easy to be remembered.

EXAMPLE—(*the same as Example I. preceding.*)

Suppose the apparent distance of the centre of the moon from the star Aldebaran was 47° 33′ 48″, the apparent altitude of the star 50° 31′, the apparent altitude of the moon's centre 70° 47′, and the proportional logarithm of the moon's horizontal parallax 5199. Required the true distance of the centre of the moon from the star?

☽ App. Alt. 70° 47′						
✱ App. Alt. 50 31						
Sum . . 121 18	Half Sum	60°	39′		tan.	10.25002
Diff. . . 20 16	Half Diff.	10	8		co-t.	10.74731
	Half Dist.	23	47		tan.	9.64415
	Angle A	77	9		tan.	10.64198
Differ. is	1st Angle	53	22		tan.	10.1287
	✱ Ap. Alt.	50	51		co-t.	9.9158
	Cor. ✱ Alt.			47″	P. L.	2.3613
	First Corr.		42		P. L.	2.1058
Sum is second Angle		100	56		tan.	10.7140
	☽ App. Alt.	70	47		co-t.	9.5423
	Cor. ☽ Alt.		17′	34″	P. L.	1.0106
	Second cor.		9	44	P. L.	1.2669

Hor. Par. P. L.	10.5199			
☽ App. Alt. 70° 47′ cor.	9.5174	✱ Ref. 47		
17′ 54″ P. L.	1.0025			
20 ☽ Refraction				
17 34 cor. ☽ Alt.				
Apparent Distance		47°	33′	48″
1st cor. add . .				42
		47	34	30
2d cor. sub. . .			9	44
3d Angle . . .		47	24	46
3d cor. . . .				1
True distance . .		47	24	47

Diff. 2″ from the former method.

If the star's altitude had been greater than the moon's, the angle A would have been 102° 51′. The first angle in this example is 53° 22′ and the refraction (Table XII.) corresponding, is 43″, which is nearly equal to the first correction.

Method of taking a Lunar Observation by one observer.

Three observers are required to make the necessary observations for determining the longitude; one to measure the distance of the bodies, and the others to take the altitudes. In case of not having a sufficient number of instruments or observers to

* Both numbers must be taken from the same vertical column, as was observed in the note to the second method, and the other remarks of that note are applicable to this method.

take the altitudes it has been customary to calculate them ; there being given the latitude of the place, the apparent time, the right ascensions and the declinations of the objects. These calculations are long, when an altitude of a star is to be computed, and much more so when that of the moon is required ; and a considerable degree of accuracy is required in finding, from the Nautical Almanac, the moon's right ascension and declination, which must be liable to some error on account of the uncertainty of the ship's longitude. The following method of obtaining those altitudes is far more simple, and sufficiently accurate. This method depends on the supposition that the altitudes increase or decrease uniformly.

Before you measure the distance of the bodies, take their altitudes, and note the times by a watch, then measure the distance and note the time (or you may measure a number of distances, and note the corresponding times, and take the mean of all the times and distances for the time and distance respectively)—after you have measured the distances, again measure the altitudes, and note the times : Then from the two observed altitudes of either of the objects, the sought altitude of that object may be found in the following manner :

Add together the proportional logarithm (Table XXII.) of the variation of altitude* of the object between the two times of observing the altitudes, and the prop. log. of the time elapsed between taking the first altitude and measuring the distance ; from the sum subtract the prop. log.† of the time elapsed between observing the two altitudes of that object ; the remainder will be the prop. log. of the correction to be applied to the first altitude, additive or subtractive according as the altitude was increasing or decreasing ; to the altitude thus corrected, apply the correction for dip of the horizon and semi-diameter as usual.

EXAMPLE.

Suppose the distances and altitudes of the sun and moon were observed as in the following Table : It is required to find the altitudes at the time of measuring the mean distance ?

	Time.	Dist. ☉ and ☽ N L.
	2h. 3m. 20s.	40° 0′ 0″
	4 20	0 30
	5 50	1 30
Mean.	2 4 30	40 0 40

Time.	Alt.	Observed. ☽'s L. L.	Time.	Alt.	Observed. ☉'s L. L.
2h. 2m.	0s.	20° 46′	2h. 2m.	30s.	40° 20′
6	10	21 20	7	0	39 12
4	10	34	4	30	1 8

Var. ☽'s alt.	34′	P. L.	7238
Time 1st. obs ☽	2h. 2′ 0″		
Mean obs. of dist.	2 4 30		
Difference	2 30	P. L.	1.8573
			2.5811
Elapsed time between the two observations	4′ 10″	P. L.	1.6356
Correction of alt.	0° 20′	P. L.	9456
1st. alt. of moon	20 46	add	
Alt. ☽'s L. L. at time of the mean obs.	21 6		

Variation ☉'s alt.	1° 8′	P. L.	4228
Time 1st obs. sun	2h. 2′ 30″		
Time mean obs.	2 4 30		
Difference	2 0	P. L.	1.9542
Sum			2.3770
Elapsed time between the two observations	4′ 30″	P. L.	1.6021
Correction of alt.	0° 30′	P. L.	7749
Sub. from sun's 1st. alt.	40 20		
Alt. ☉'s L. L. at time of the mean obser.	39 50		

Thus at the time 2h. 4′ 30″, the mean observed distance of the sun and moon's nearest limbs was 40° 0′ 40″, the altitude of the moon's lower limb 21° 6′, and the altitude of the sun's lower limb 39° 50′ ; these altitudes must be corrected for dip and semi-diameter as usual.

* Table XXII. is only calculated as far as 3°, and if the variation of altitude exceed that quantity, you must enter the table with minutes and seconds, instead of degrees and minutes, and the correction of altitude taken out in minutes and seconds must be called degrees and minutes respectively.

† Or add its arithmetical complement, neglecting 10 in the index of the sum.

In this manner I have often obtained the altitudes in much less time than they could have been obtained by other calculations.

The same method may be used for finding the sun's altitude, when taking an azimuth, by noting the times of taking the observations by a watch, and taking two altitudes, the one before, the other after the observation, and proportioning the altitudes as above.

Any person who wishes to calculate strictly the apparent altitudes, may proceed according to the following rules.

The apparent time, the ship's latitude and longitude, and the sun's declination given, to find the apparent altitude of his centre.

RULE.

With the apparent time from noon, enter Table XXIII. and from the column of rising take out the logarithm corresponding, to which add the log. co-sine of the latitude, and the log. co-sine of the sun's declination ; their sum, rejecting 20 in the index, will be the logarithm of a natural number, which being subtracted from the natural co-sine of the sum of the declination and latitude, when they are of different names, or the natural co-sine of their difference when of the same name, will leave the natural sine of the sun's *true* altitude at the given time. The refraction less parallax being added to the true altitude, will give the *apparent* altitude.

In general it will be near enough to take out the refraction only from Table XII. and neglect the parallax.

EXAMPLES.

Required the true altitude of the sun's centre, in lat. 49° 57′ N. and long. 75° W. July 26, 1820, at 6h. 56m. 30s. in the morning, sea account ?

	H.	M.	S.		
	12	0	0		
App. time	6	56	30		
Time from noon	5	3	30	its log. in col. of rising	4.87850
Latitude	49	57	0N.	its log. co-sine	9.80852
Declin. at that time	19	26	0N.	its log. co-sine	9.97453
				nat. number . . . . . . .45872 its log. =	4.66155
Difference	30	31		nat. co-sine 86148	
True alt.		23°	45′	nat. sine 40276	
Refraction			2		
App. alt.		23	47		

EXAMPLE II.

What will be the true altitude of the sun's centre in the latitude of 39° 20′ N. and the longitude of 40° 50′ W. November 26, 1820, at 3h. 21m. 30s. apparent time in the afternoon, sea account ?

	H.	M.	S.		
App. time from noon	3	21	30	its log. in col. of rising	4.55900
Latitude	39	20	0N.	log. co-sine	9.88844
Declin. at that time	20	52	0S.	log. co-sine	9.97054
				nat. number . . . . . . 26181 its log. =	4.41798
Sum	60	12		nat. co-sine 49697	
True alt.	13	36		nat. sine 23516	
Refraction		4			
App. alt.	13	40			

The apparent time, the latitude and longitude given, to find the apparent altitude of a fixed star.

RULE.

Turn the longitude into time, and add it to, or subtract it from, the apparent time*

* The apparent time must be taken (as usual) one day less than the sea account, and the hours must be reckoned from noon to noon in numerical succession from 1 to 24. It may also be observed, that if the observer be furnished with a chronometer, regulated to *mean* Greenwich time, this part of the operation may be saved, reducing the *mean* time to *apparent*, by applying the equation Table IV. A, with a *different* sign from that in the Table, as is taught in the introduction to the tables.

at the ship, according as the longitude is west or east, the sum or difference will be the time at Greenwich.

Find, in the Nautical Almanac, the sun's right ascension for the noon preceding the time at Greenwich, and add thereto the correction taken from Table XXXI. corresponding to the hours and minutes of the time at Greenwich, the sum will be the sun's right ascension, which being added to the apparent time at the ship, will give the *right ascension of the meridian*, rejecting 24 hours when the sum exceeds 24 hours.

Find the star's right ascension and declination in Table VIII. for the year 1820, and correct them for the years elapsed since that time, by means of the annual variations given in the same table, and you will obtain the star's right ascension and declination at the time of observation.*

The difference between the star's right ascension and the right ascension of the meridian, will be *the distance of the star from the meridian*.

Find in the column of rising of Table XXIII. the logarithm corresponding to the star's distance from the meridian,† and add thereto the log. co-sine of the latitude of the ship, and the log. co-sine of the declination of the star, the sum, rejecting 20 in the index, will be the logarithm of a natural number (Table XXVI.) which subtracted from the natural co-sine (Table XXIV.) of the *sum* of the declination and latitude when of different names, or the natural co-sine of their difference when of the same name, will leave the natural sine of the star's *true* altitude.

The refraction being added to the true altitude will give the *apparent* altitude.

EXAMPLE.

What was the apparent altitude of Aldebaran, at Philadelphia, April 12, 1820, sea account, at 5h. 57m. 18s. in the afternoon, apparent time?

In Table VIII. the right ascension of Aldebaran for 1820, is 4h. 25m. 36s. and the variation for 3½ months is 1″ to be added because the time is after 1820; hence the right ascension at the given time 4h. 25m. 37s. The declination of the star for 1820 is 16° 8′ N. its variation for 3½ months being neglected.

	H. M. S.		
Apparent time by N. A. April 11,...	5 57 18		
Longitude 75° 9′ W.	5 0 36		
Time at Greenwich, April 11......	10 57 54		
☉'s R. A. April 11, at noon, by N. A.	1 19 28		
Var. for 10h. 57′ 54″ by Table XXXI.	1 41		
☉'s R. A. at time of obs.	1 21 9		
Apparent time	5 57 18		
R. A. Mer.	7 18 27		
✳'s R. A.	4 25 37		
✳'s dist. from merid.	2 52 50	Its log. in col. rising.....	4.43318
Latitude of Philadelphia 39° 57′ N.		co-sine....	9.88457
✳'s declination .... 16 8 N.		co-sine....	9.98255
	nat. number	19966 its log.	4.30030
Difference 23 49	nat. co-sine	91484	
True altitude 45 39	nat. sine	71518	
Refraction 1			
Apparent altitude 45 40			

* If any of the 24 bright stars are used, whose right ascension or north polar distances are given for every 10 days in the year in the Nautical Almanac, we can obtain from it by inspection the right ascension, and deduce the declination from the polar distance, and the numbers thus found having been corrected for aberration and nutation, are to be used as rather more accurate.

† If the distance from the meridian exceed 12 hours, you must subtract from 24 hours before entering table XXIII.

The apparent time, and the latitude and longitude of the ship given, to find the apparent altitude of the moon's centre.

Turn the longitude into time (by Table XXI.) and if in west longitude add it to, but in east longitude subtract it from the apparent time* at the ship, the sum or difference will be the time at Greenwich.

Take the sun's right ascension out of the N. A. for the preceding noon at Greenwich, and add thereto the correction taken from Table XXXI. corresponding to the hours and minutes of the time at Greenwich, the sum will be the sun's right ascension, which being added to the apparent time at the ship, will give the right ascension of the meridian, rejecting 24 hours when the sum exceeds 24 hours.

Take from the N. A. the moon's right ascension and declination for the time immediately preceding and following the time at Greenwich, and proportion for the time at Greenwich, by means of Table XXX. and you will obtain the moon's right ascension and declination at the time of observation.

Turn the moon's right ascension into time (by Table XXI.) and the difference between that time and the right ascension of the meridian, will be the moon's distance† from the meridian; with which enter table XXIII. and take out the corresponding logarithm from the column of rising, and add thereto the log. co-sine of the latitude of the ship, and the log. co-sine of the declination of the moon, the sum, rejecting 20 in the index, will be the logarithm of a natural number (Table XXVI.) which subtracted from the natural co-sine (Table XXIV.) of the sum of the declination and latitude when of different names, or the natural co-sine of their difference when of the same name, will leave the natural sine of the moon's *true* altitude; from which, subtracting the correction corresponding to the altitude in Table XXIX.‡ there will remain the *apparent* altitude nearly.

EXAMPLE.

What was the moon's apparent altitude April 29, 1820, sea account, at 7h. 55m. 52s. P. M. in lat. 42° 34′ S. long. 65° 7′ 30″ W. from Greenwich?

	H.	M.	S.
April 29, sea account is April 28 by N. A. at	7	55	52
Long. 65° 7′ 30″ W. in time	4	20	30
App. time at Greenwich	12	16	22
Sun's Rt. ascen. April 28, at 12h. 16′ 22″ P. M. by N. A.	2	24	44
Apparent time at the ship	7	55	52
Right ascension of the meridian	10	20	36
☽ 's right ascension in time	14	48	20
☽ 's distance from the meridian	4	27	44

Corresponding to which in the col. log. rising is						4.78404
Latitude	42°	34′ S.			co-sine	9.86717
☽ 's declination ...	20	0 S.			co-sine	9.97299
			nat. num.	42092	log.	4.62420
Difference	22	34	nat. co-sine	92343		
☽ 's true alt.	30	10	nat. sine	50251		
Cor. Table XXIX.		48				
☽ 's App. alt.	29	22				

* The apparent time is to be counted from noon to noon, as directed in the preceding note.

† When the distance exceeds 12h. you must enter table XXIII. with the difference between that distance and 24 hours.

‡ In strictness you ought, instead of this correction, to use the correction of the moon's altitude, corresponding to her apparent altitude and horizontal parallax.

To find the Longitude by the Eclipses of Jupiter's Satellites.

The eclipses of the satellites are given in page III. of the month of the Nautical Almanac for *mean* time at Greenwich. There are two kinds of these eclipses—an *Immersion*, denoting the instant of the disappearance of the satellite by entering into the shadow of Jupiter, and an *Emersion*, or the instant of the appearance of the satellite in coming from the shadow. The immersions and emersions generally happen when the satellite is at some distance from the body of Jupiter, except near the opposition of Jupiter to the sun, when the satellite approaches near to his body. Before the opposition they happen on the west side of Jupiter, and after the opposition on the east side; but if an astronomical telescope is used which reverses the objects, the appearance will be directly the contrary. The configurations, or the positions in which Jupiter's satellites appear at Greenwich, are laid down every night, when visible, in page XII. of the month of the Nautical Almanac.

As these eclipses happen almost daily, they afford the most ready means of determining the longitude of places on land, and might also be applied at sea, if the observations could be taken with sufficient accuracy in a ship under sail, which can hardly be done, since the least motion of a telescope which magnifies sufficiently to make these observations, would throw the objects out of the field of view.

As these eclipses are given in the Nautical Almanac in mean time, it is necessary to regulate your watch to mean time;* this is easily obtained from the apparent time by applying to the latter the equation of time taken from the Nautical Almanac, by adding or subtracting according to the directions in the column from whence the equation was taken; hence the error of a watch with respect to mean time may be ascertained.

The watch being thus regulated, you must then find nearly the time at which the eclipse will begin at the place of observation; this may be done as follows: Find from the Nautical Almanac the time of an immersion or emersion, and apply thereto the longitude turned into time, by adding when in east, but subtracting when in west longitude, the sum or difference will be nearly the mean time when the eclipse is to be observed at the given place. If there be any uncertainty in the longitude of the place of observation, you must begin to look out for the eclipse at an earlier period; and when the eclipse begins, you must note the time by the watch, and after applying the correction for the error of the watch, if there be any, you will have the mean time of the eclipse at the place of observation; the difference between this and the time in the Nautical Almanac, being turned into degrees, will be the longitude from Greenwich.

EXAMPLE.

Suppose that on the 21st of August, 1820, sea account, in the longitude of 127° 55′ W. by account, an immersion of the first Satellite of Jupiter was observed at 7h. 12m. 32s. P. M. mean time. Required the longitude?

By N. A. immersion	Aug. 20th.	15h. 47′ 52″
By observ. Aug. 21, sea account, or by N. A.	Aug. 20th.	7 12 32
Longitude in time.....................................		8 35 20

which turned into degrees gives 128° 50′ W. for the longitude of the place of observation.

To find the Longitude by Eclipse of the Moon.

The determination of the longitude by an eclipse of the moon is performed by comparing the times of the beginning or ending of the eclipse, as also the times when any number of digits are eclipsed, or when the earth's shadow begins to touch or leave any remarkable spot on the moon's face; the difference of time between the like observations made at different places, turned into degrees, will be the difference of longitude of those places.

When the beginning or end of an eclipse of the moon is observed at any place, the longitude of that place may be easily found by comparing the time

* In the Almanacs published before 1805, the *apparent* time of the eclipses was given instead of the mean time.

of observation with the time given in the Nautical Almanac, for the difference between the observed time of beginning or ending, and the time given in the Nautical Almanac, will be the ship's longitude in time, which may be turned into degrees by Table XXI. Thus if the beginning of an eclipse of the moon was observed March 30, 1820, sea account, at 9h. $59\frac{5}{6}$m. the time by the N. A. being March 29 or March 30, sea account, at 5h. $16\frac{5}{6}$m. their difference 4h. 43m. is the longitude of the place of observation $=70^{\circ}$ 45′, which is east from Greenwich, because the time at the place of observation is greatest.

*To find the Longitude by a perfect time-keeper or chronometer.**

It was before observed, that if a chronometer could be made in so perfect a manner as to move uniformly in all places, and at all seasons, the longitude might easily be deduced therefrom, by comparing the time shown by the chronometer, regulated to the meridian of Greenwich (or some other known meridian) with the mean time at the place of observation. For the difference of these times would be the difference of longitude between that meridian and the place of observation. The moderate price of good chronometers now, in comparison with their values many years since, together with the various improvements in their construction, have caused this method of determining the longitude to be much more used within a few years, than it was when the first editions of this work were published: we shall therefore explain more fully the use of this instrument, and the methods of regulation.

If a chronometer is to be used on a voyage, it must be adjusted, and its rate of going ascertained, before sailing. This may be done by taking altitudes of the sun or some other heavenly body, and finding therefrom the *apparent* time of observation, by any of the methods before given in pages 154—161. To this time must be applied the *equation of time*, found in page II. of the month of the Nautical Almanac, or in Table IV. A (reduced to the moment of observation by means of Table VI. A) by adding the equation to, or subtracting it from, the apparent time, according to the directions given in or at the top of each column of the table, the sum or difference will be the *mean time* of observation, being the same time as would be shown by a chronometer whose motion is perfectly uniform. Comparing this *mean* time of observation with the time by the chronometer, shows how much it is then too *fast* or too *slow* for the meridian of the place of observation; and by repeating the operation on a future day, the rate of going may be ascertained. If it is found to *gain* or *lose* a few seconds or parts of a second per day, that allowance must be made on all future observations at sea. Thus, if on the 1st of June, 1824, at 5h. 10m. 20s. by the chronometer, the *mean* time, deduced from an observation of the sun's altitude, was 5h. 12m. 40s. the chronometer would then be too slow by the difference of those times 2m. 20s. and if on the 21st of June following the time by the chronometer was 4h. 15m. 35s. when the mean time was 4h. 18m. 17s. the chronometer would then be too slow by the difference of those times or 2m. 42s. and the rate would have varied in 20 days from 2m. 20s. to 2m. 42s. which is a difference of 22 seconds in 20 days, being $1\frac{1}{10}$ seconds per day, and this rate must be allowed on all future observations at sea, until a new regulation can be obtained, at some place whose longitude is known. It is best to have a considerable number of days interval between the two observations for fixing the rate, by which means it may be determined to tenths of a second, the absolute error of the observations being reduced in finding the daily rate, by dividing by the number of days. Thus if the above difference of 22 seconds had been erroneous 2s. and the true value 20s. the daily rate would be *one* second instead of 1s.1, varying only one tenth of a second, notwithstanding the observations on which the rate was established, contained an error of 2 seconds.

* The Chronometers most celebrated for correctness are those made by Mr. French, London, and for sale by JAMES LADD, No. 30 Wall-street, New-York, who mechanically understands that valuable instrument.
Proprietor.

Having regulated a chronometer, in the manner first mentioned, at a place whose longitude from Greenwich is known, it is easy to find how much it is too fast or too slow for the meridian of Greenwich, by allowing for the difference of meridians. Thus, if the above mentioned observation of June 1, was made in place in 74° west longitude, corresponding in Table XXI. to 4h. 56m. the chronometer on that day would be too slow for Greenwich time by the sum of 4h. 56m.* and 2m. 20s. or 4h. 58m. 20s. In general it will be full as simple, when thus regulating a chronometer, at a place whose longitude is known, to reduce at once the mean time at the place of observation to the meridian of Greenwich, by *adding* the longitude if west, *subtracting* if east, the sum or difference will be the *mean* time of observation upon the meridian of Greenwich, the difference between this and the time given by the chronometer, shows how much it is too fast or too slow for Greenwich *mean* time. Thus by adding the longitude 4h. 56m. to the *mean* time of the above observation 5h. 12m. 40s. the sum 10h. 8m. 40s. is the *mean* time at Greenwich, from which subtracting the time by the chronometer 5h. 10m. 20s. the remainder 4h. 58m. 20s. is what the chronometer is too *slow* for Greenwich time, as was found before.

The chronometer having been thus regulated to Greenwich time, and the daily rate of its going ascertained, if this rate should remain unaltered, the time at Greenwich will be known by it, at any moment at sea, and if at that moment by any observation of the sun, moon, planet or a fixed star, the *apparent* time be found by any of the methods explained in pages 154—161, and the *mean* time at the ship deduced therefrom, by applying the equation of time, as above explained, then the difference between this mean time at the ship, and the mean time at Greenwich shown by the chronometer, will be the longitude, which may be turned into degrees and minutes by Table XXI. We shall explain by a few examples the preceding remarks.

EXAMPLE I.

Wishing to regulate a chronometer, in a place whose latitude is 51° 30′ N. and longitude 114° E. from Greenwich, I observed Oct. 10, 1824, at 8h. 21m. A. M. sea account per chronometer, the altitude of the sun's lower limb, by a fair observation 13° 32′, the correction for semi-diameter, parallax and dip being 12′. It is required to find the errror of the chronometer for *mean* time at Greenwich ?

The apparent time of this observation, computed as in Example I. page 158, is 8h. 7m. 9s. A. M. corresponding to Oct. 9d. 20h. 7m. 9s. by the Nautical Almanac. From this subtract† the longitude 114° turned into time 7h. 36m. by Table XXI. the remainder Oct. 9d. 12h. 31m. 9s. is the *apparent* time at Greenwich. Now by Table IV. A, the equation of time for Oct. 9d. at noon is *sub.* 12m. 44s. with a daily *increase* of 16s. and this in Table VI. A, under 16s. and opposite to 12h. 31m. 9s. gives 9s. to be added to 12m. 44s. (because it is increasing) the sum 12m. 53s. is the equation of time, which by the table is subtractive from the *apparent* time at Greenwich Oct. 9d. 12h. 31m. 9s. to obtain the *mean* time at Greenwich Oct. 9d. 12h. 18m. 16s. If the mean time at the *place of observation* is required, it would be found by subtracting the equation of time 12m. 53s. from the apparent time at the place of observation, 8h. 7m. 9s. and it would therefore be 7h. 54m. 16s.

EXAMPLE II.

May 10, 1824, at 5h. 30m. P. M. sea account per chronometer, in latitude 39° 54′, in a place whose longitude was known to be 17° 30′ E. from Greenwich, the altitude of the sun's lower limb by a fore observation was 15° 45′, the correction for dip, parallax and semi-diameter being 12′. It is required to find the error of the chronometer for mean time at Greenwich, and at the place of observation ?

---

* If the longitude had been east, it would have been subtractive.
† This is to be *added* if the ship's longitude is *west*.

The apparent time of this observation, computed as in Example II. page 156, is May 9d. 5h. 34m. 26s. by the Nautical Almanac. From this subtract* the longitude 17° 30′, turned into time, 1h. 10m. by Table XXI. the remainder May 9d. 4h. 24m. 26s. is the *apparent* time at Greenwich, By Table IV. A, the equation of time for May 9th. at noon is *sub.* 3m. 48s. with a daily increase of 3s. and this in Table VI. A, under 3s. and opposite 4h. 24m. 26s. is 1s. which added to 3m. 48s. (because it is increasing) gives the equation of time, at the moment of observation, *sub.* 3m. 49s. Subtracting this, according to the direction in the table, from the *apparent* time at Greenwich May 9d. 4h. 24m. 26s. leaves the *mean* time at Greenwich May 9d. 4h. 20m. 37s. Subtracting the same equation 3m. 49s. from the *apparent* time at the place of observation 5h. 34m. 26s. gives the mean time at the place of observation 5h. 30m. 37s. The difference between the *mean* time at Greenwich 4h. 20m. 37s. and the time by the chronometer 5h. 30m. is 1h. 9m. 23s. which is the time the chronometer is too fast for Greenwich *mean* time.

EXAMPLE III.

Suppose that July 27, 1820, sea account, the apparent time was found by an altitude of the sun to be 1h. 5′ 8″ P. M. when by a watch well regulated to mean Greenwich time, the time was 4h. 3′ 8″ P. M. Required the longitude?

Apparent time.................	1h.	5′	8″
Equation of time add..........		6	8
Mean time at place of observation	1	11	16
Time per watch................	4	3	8
Difference in long............	2	51	52=42° 58′ W.

the longitude being west, because the time at Greenwich is the greatest.

EXAMPLE IV.

Suppose that May 14, 1820, sea account, the apparent time was found by an altitude of the sun to be 4h. 3′ 5″ P. M. when the time by the watch was 2h. P. M. the watch being too slow for mean Greenwich time 11′ 9″. Required the longitude?

Apparent time...............	4h.	3′	5″
Equation of time sub.........		3	56
Mean time at place of observ.	3	59	9 P. M.
Time at Greenwich...........	2	11	9
Difference of longitude.......	1	48	0=27° 0′ E.

Time per watch	2h.	0′	0″
Watch error add		11	9
Time at Greenwich	2	11	9 P. M.

EXAMPLE V.

Suppose that on June 14, 1820, sea account, in a place whose longitude from Greenwich was known, a number of observations were taken to ascertain the going of the watch; and it was found that on that day it was 10″ too slow for mean Greenwich time, and lost time 2″ per day; and that on July 14, 1820, sea account, the time per watch was 6h. 0′ 6″ P. M. when, by an observed altitude of the sun, the apparent time was 1h. 16′ 10″ P. M. Required the longitude?

Apparent time............	1h.	16′	10″
Equation of time add......		5	22
Mean time at place of obser.	1	21	32
Time at Greenwich..........	6	1	16
Longitude.................	4	39	44=69° 56′ W.

Error of watch, June 14, ...		0′	10″	slow
30 days at 2″		1	0	slow
Error July 14, ...		1	10	slow
Time per watch	6	0	6	
Time at Greenwich	6	1	16	

* This is to be *added* if the ship's longitude is west.

To regulate a Chronometer by Lunar Observations.

It sometimes happens that a chronometer is by accident suffered to run down when at sea, in which case it can be regulated, by means of a great number of lunar observations, which must be taken with the greatest care, and with objects on different sides of the moon. These observations may be made on the same day, or on several successive days, finding by each observation how much the chronometer is too fast or too slow for Greenwich time, and taking the mean result for the error at the mean time of observation.

EXAMPLE I.

1820.		m. s.
April 6.	Too fast 1st. obs.	2 12
" "	——— 2d. obs.	2 08
" "	——— 3d. obs.	2 06
" "	——— 4th. obs.	2 10
		4) 36
Mean error	. . .	2 9

EXAMPLE II.

1819.		m. s.
April 20.	Too slow 1st. obs.	1 19
" 21.	——— 2d. obs.	1 21
" 22.	——— 3d. obs.	1 26
		3) 66
Chro. too slow April 21,		1 22

EXAMPLE III.

1817.		m. s.
Aug. 5.	Too slow 1st. obs.	—0 24
" 6.	Too fast 2d. obs.	+0 15
" 8.	Too slow 3d. obs.	—0 7
" 9.	Too fast 4th. obs.	+0 4
		4)—0 12
Chro. too slow, Aug. 7		—0 3

In the last example some of the observations made the chronometer too slow, and others too fast; these are marked with different signs + and —, the sum is to be found, noticing the signs in the algebraical manner, as taught in the introduction to the appendix of this work.

It has lately been discovered that chronometers generally go faster on board of a vessel than when on shore; this variation has been sometimes found to be as much as 14 seconds per day, though in general not more than 1 or 2 seconds. It is suspected that this arises from the attraction of the iron in the vessels, the chronometer having acquired a small degree of magnetism. To remedy this inconvenience it has been recommended to keep the chronometers always in the same place on board the ship, and to regulate them when thus placed, before leaving the port, or by means of lunar observations (after the above manner) when at sea. Thus, in the first of the above examples, the chronometer was 2m. 9s. too fast for Greenwich time April 9, 1820, suppose now by a set of lunar observations made April 30, 1820, it was found to be fast 2m. 30s. the variation would be 21s. in 21 days, which is 1 second per day for the acceleration of the chronometer.

It has also been found that chronometers generally *gain* by an *increase* of density of the air, and *lose* by a *decrease* of density. The firing of guns on board a vessel will sometimes alter the rate of going, unless the instrument be well suspended, or held in the hand during the firing. Any sudden jar will sometimes alter the rate. The imperfection of the oil used will after sometime impair the instrument. Finally, the mechanism used to correct the change of temperature of the air may not do it completely, and some error may arise from this source. Notwithstanding these various causes of error, it is wonderful to observe how accurately some of those chronometers perform their office.

To find the Longitude by a Variation Chart.

In the year 1700, Dr. Halley proposed to find the longitude by a chart he published, on which the lines of the variation of the compass were drawn; and since that time several similar charts have been published for the same purpose; but the difficulty of determining the variation, combined with other causes, will probably prevent this method from being sufficiently accurate to be generally useful.

The method of using this chart is as follows: On the parallel of latitude which you are in, find the observed variation, and that point will be the place of observation.

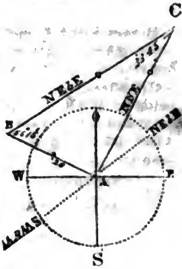
A chart, on which the lines of the dip of the magnetic needle are marked, might be used in the same manner for determining the longitude.

PROBLEMS USEFUL IN NAVIGATION.

PROBLEM I.

Coasting along shore, I saw a cape of land bearing N. N. E. and after sailing W. N. W. 20 miles, it bore N. E. by E. Required the distance of the ship from the cape at both stations?

BY PROJECTION.



Describe the compass E. S. W. and let its centre A represent the place of the ship at the first station; draw the W. N. W. line AB equal to 20 miles, and B will represent the second station. Draw the N. N. E. line AC, of an indefinite length, and the line BC parallel to the N. E. by E. line of the compass; the point of intersection C will represent the place of the cape; and the distance BC being measured will be found 36 miles, and AC 30 miles.

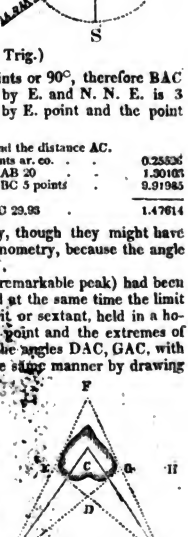
BY LOGARITHMS—(by Case I. Obl. Trig.)

The difference between N. N. E. and W. N. W. is 8 points or 90°, therefore BAC is a right angle; also the difference between the N. E. by E. and N. N. E. is 3 points=angle ACB and the difference between the N. E. by E. point and the point opposite to W. N. W. is 5 points, equal to the angle ABC.

To find the distance BC.		To find the distance AC.	
As si. ang. ACB 3 points . ar. co.	0.25526	As sine ACB 3 points ar. co. . .	0.25526
Is to the distance AB 20 . .	1.30103	Is to the distance AB 20 . .	1.30103
So is sine angle BAC 8 points .	10.00000	So is sine angle ABC 5 points .	9.91985
To the distance BC 36.0 . .	1,55629	To the distance AC 29.93 .	1.47614

The above solutions are by case I. Oblique Trigonometry, though they might have been done in this example by case II. of Right-Angled Trigonometry, because the angle BAC is a right-angle.

If the bearings of the middle point C of an Island (or any remarkable peak) had been taken and determined in this manner, you might have found at the same time the limit of the dimensions of the island, by measuring with a quadrant or sextant, held in a horizontal position, the angular distances between that middle point and the extremes of the island. For by drawing the lines ADE, AGF, making the angles DAC, GAC, with AC equal to the angular distances observed at A; and in the same manner by drawing the lines BDG, BEF, making angles with BC equal to the angular distances observed at B, you would obtain the quadrilateral figure DEFG, within which the island is to be placed. If similar observations could be procured at H, they would in general take off the corners at D and F; and observations at I, would generally take off the corners at E and G; and by observing the projecting points and coves in the island, while sailing round it, and drawing a figure conformable thereto within the limiting space thus found, the form and dimensions of the island may be obtained to a considerable degree of accuracy.

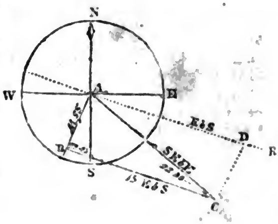


PROBLEM II.

Being at sea, I saw two headlands whose bearing from one another by the chart was W. by N. and E. by S. and distance 15 miles; the westernmost bore from me S. S. W. and the easternmost S. E. by E. Required my distance from each of them?

BY PROJECTION.

Draw the compass N. E. S. W. and through the centre A, draw the E. by S. line AR, the S. S. W. line AB, and the S. E. by E. line AC, and continue the two latter indefinitely, but upon the former AR take AD=15 miles; through D draw DC parallel to AB, to meet AC in C, and draw CB parallel to AD. Then A will be the place where the headlands B and C were observed; and the distance AB of the westernmost headland being measured, will be found to be 5,8 miles, and the distance AC of the easternmost headland 15 miles.



BY LOGARITHMS.

Between the S. S. W. line AB and the S. E. by E. line AC, are 7 points, $= <$ BAC; and between the S. E. by E. line AC, and the E. by S. line AD are 2 points $= <$ CAD $= <$ ACB (because AD, BC are parallel)—therefore ACB+BAC=9 points, and since all three angles ACB, BAC, ABC are equal to 16 points, the angle ABC is also equal to 7 points, therefore *(by art. 39 Geom.)* the sides AC, CB are equal, being opposite to the equal angles ABC, BAC. If these angles had not been equal, the side AC might have been calculated in the same manner as we shall now calculate the side AB.

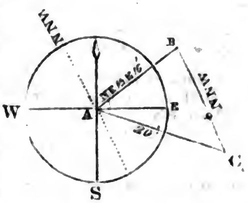
To find the side AB.	
As sine BAC 7 points co. ar.	0.00843
Is to BC 15 miles	1.17609
So is sine ACB 2 points	9.58284
To AB 5.85	0.76736

This Problem or the first may be used for finding the distance of a ship from any headland, &c. when taking her departure from the land.

PROBLEM III.

Two ships sail from the same port, one sails N. E. ½ E. 16 miles, the other sails easterly 20 miles, and then finds that the first bears N. N. W. Required the other ship's course, and the distance between the two ships?

BY PROJECTION.



Draw the compass ESW, and let its centre A represent the port sailed from; draw the N. E. ½ E. line AB= 16 miles, and through B, the line BC, parallel to the N. N. W. line, and continue it indefinitely; take 20 miles in your compasses, and putting one foot in A, describe with the other an arch cutting the line BC in C, and join AC. Then B will be the place of the first ship, C that of the second, and AC the course steered by the second ship, which will be nearly E. S. E. ½ E. and BC the distance of the ships 17½ miles.

BY LOGARITHMS.

The course from B to C is S. S. E. (opposite to N. N.W.) and from B to A is S. W. ½ W. (opposite to N. E. ½ E.) the difference between these bearings is 6½ points=73° 7'=the angle ABC; having this angle and the sides AB, AC, the other angles and side may be found by Cases II. and III. of Oblique Trigonometry as follows:

To find the angle C.	
As the side AC 20 miles	1.30103
Is to sine ABC 73° 7'	9.93087
So is side AB 16 miles	1.20412
	11.18499
Subtract	1.30103
To sine angles C 49° 57'	9.88396
For N. N W. add 22 30	

Sum makes N. 72 27 W. the bearing of A from C, whence the course of the ship from A towards C, is S. 72° 27' E. or E. S. E. ½ E. nearly.

To find the distance of the ships BC.

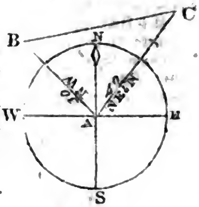
And the angle C=49° 57' to the angle B 73° 7', the sum 123° 4' being subtracted from 180° leaves the angle CAB 56° 56'.

As sine ang. ABC 73° 7' ar. co.	0.01913
Is to the side AC 20 miles	1.30103
So is sine CAB 56° 56'	9.92326
To the side BC 17.5 miles	1.24342

PROBLEM IV.

Two ships sail from the same port, one N. W. 30 miles, and the other N. E. by N. 40 miles. Required the bearing and distance of the ships from each other?

BY PROJECTION.



Draw the compass NESW, and let its centre A represent the port sailed from; draw the N. W. line AB=30 miles, and the N. E. by N. line AC=40 miles, join BC, which will be the bearing and distance of the two ships. Whence the bearing will be found to be W. S. W. ½ W. and the distance 45.1 miles nearly.

BY LOGARITHMS (by Cases IV. and V. Ob. Trig.)

Between the N. W. line AB and the N. E. by N. line AC, there are 7 points=angle BAC, half the supplement of which to 180° is 50° 37½′=half sum of the angles C and B.

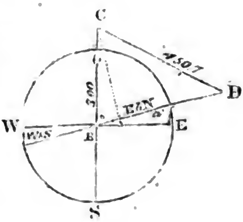
To find the angles.				To find the distance BC.		
As sum of AB and AC 70 log. ar. co.		8.15490		As sine angle B 60° 30′ ar. co.		0.06030
Is to their difference 10		1.00000		Is to side AC 40		1.60206
So is tang. ½ sum angles	50° 37½′	10.08583		So is sine angle A 78 45		9.99157
To tan. ½ diff.	9 52½	9.24073		To the distance BC 45.1		1.65393
Sum=angle B	60 30					
Diff.=angle C	40 45					

To the angle C=40° 45′, add the course from C to A=33° 45′, the sum is 74° 30′, which is the bearing of B from C, viz. S. 74° 30′ W. or W. S. W. ½ W. nearly.

PROBLEM V.

Two ports bear from each other E. by N. and W. by S. distance 400 miles; a ship from the easternmost sails northerly 450,7 miles, another from the westernmost sails 300 miles, and meets the first. Required the course steered by each ship?

BY PROJECTION.



Draw the compass ESW, and let the centre B represent the westernmost port; draw the E. by N. line BD=400 miles, and D will be the easternmost port; with 300 in your compasses and one foot in B, describe an arch; with 450,7 in your compasses, and one foot in D, describe another arch cutting the former in C; join DC, BC. Then BC will be the course sailed by the westernmost ship, and DC the course sailed by the easternmost.

BY LOGARITHMS.

To find the angle CBD.

By Theo. IV. Trig.

Divide the triangle BCD into two right-angled triangles by means of the perpendicular CA, and bisect BD in a, then

As the base BD 400 ar. co.		7.39794
Is to the sum of BC, CD,	750.7	2.87547
So is diff. of BC, CD,	150.7	2.17811
To twice A a	282.8	2.45152
Half or A a	141.4	
½ BD=Ba=	200	
Diff. is BA	58.6	

Then in the triangle ACB.

As hypot. DC 300	2.47712
Is to radius 90°	10.00000
So is AB 58.6	1.76790
To co-sine CBD 78° 44′	9.29078

By Theo. V. Trig.

CD=450.7			
BD=400		log. ar. co.	7.39794
BC=300		log. ar. co.	7.52288
Sum	1150.7		
½ sum	575.35	log.	2.75993
½ sum less CD	124.65	log.	2.09569
		sum	19.77644
Half sum 39° 22′		co-sine	9.88822
2			

Doubled is 78 44=Angle CBD. Having found this angle, we may find either of the others thus,

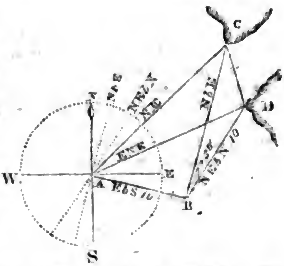
To find the angle CDB.

As CD 450.7 ar. co.	7.34611
Is to sine CBD 78° 44′	9.99153
So is BC 300	2.47712
To sine CDB 40° 45′	9.81476

As the angle CBD is 78° 44′ or 7 points nearly, and the course from B to D is E. by N. the course from B to C must be north. The course from D to B being W. by S. or W. 11° 15′ S. and the angle BDC=40° 45′ the bearing of C from D must be W. 29° 30′ N. because 40° 45′—11° 15′=29° 30′.

PROBLEM VI.

Coasting along shore, I saw two headlands, the first bore from me N. E. the second E. N. E.—after sailing E. by S. 10 miles, the first bore N. by E. and the second N. E. by N. Required the bearing of the two headlands from each other, and their distance?



Draw the compass NESW, and let its centre A represent the place of the ship at the first station; draw the E. by S. line AB=10 miles, and B will be the place of the ship at the second station; draw the N. E. line AC, and the E. N. E. line AD; through the point B draw the lines BC, BD parallel to the N. by E. and N. E. by N. lines, and the points C and D where they intersect the lines drawn from A to the same headlands will be the points representing them respectively; join the points C and D;—then will CD be the distance of the two headlands, and a line drawn through A parallel to CD will represent the bearing of those places from each other on the compass.

BY LOGARITHMS.

In the triangle ABC, we have all the angles and the side AB to find BC. For the bearings of B and C from A are E. by S. and N. E. the difference being 5 points=BAC; and the bearings of B and A from C, are S. by W. and S. W. the difference being 3 points equal to the angle ACB.

To find the side BC.

As sine of ACB 3 pts. ar. co.	0.25526
Is to the side AB 10	1.00000
So is sine angle BAC 5 pts.	9.91985
To BC 14.97	1.17511

In the triangle ABD, we have all the angles and the side AB to find BD. For the bearings of B and A from D, are S. W. by S. and W. S. W. the difference being 3 points=BDA; and the bearings of B and D from A, are E. by S. and E. N. E. the difference being also 3 points, equal to the angle BAD; therefore the angle BAD=BDA, and (*by art.* 39 *Geom.*) BD=AB=10 miles. If these angles had not been equal, we might have calculated the side BD in the same manner as BC.

Now in the triangle CBD we have BD=10, BC=14.97, and the angle CBD=22° 30′, for the bearings of C and D from B are N. by E. and N. E. by N. differing 2 points or 22° 30′; hence we may find the other angles and side CD as in case IV. Obl. Trig.

To find the angles BCD, BDC.

As sum of BC, BD 24,97 ar. co.		8.60258
Is to their diff.	4,97	0.69636
So is tan. ha. sum. op. ang.	78° 45′	10.70134
To tang. ½ diff.	45 1	10.00028
Sum is angle BDC=	123 46	
Diff. is angle BCD=	33 44	

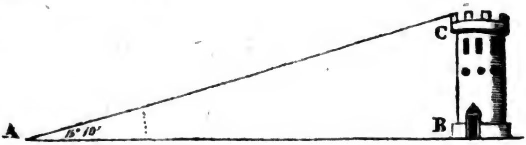
or nearly 3 points, and as the bearing of B from C is S. by W. the bearing of D from C must be S. S. E.

To find the distance CD.

As sine ang. BCD 33° 44′ ar. co.		0.25545
Is to side BD	10	1.00000
So is sine angle CBD 22° 30′		9.58284
To the distance CD	6,89	0.83829

PROBLEM VII.

Being 96 fathoms from the bottom of a tower, I found its altitude above the horizontal line drawn from my eye was 15° 10′. Required the elevation above that line?



BY PROJECTION.

Draw the horizontal line AB=96 fathoms, and perpendicular thereto, the line BC; make the angle BAC=15° 10′ and draw AC to cut BC in C, then will BC be the height of the tower 26 fathoms.

BY LOGARITHMS.

As radius 90°	10.00000
Is to the dist. AB 96 fathoms	1.98227
So is tang. angle A 15° 10′	9.43308
To the height BC 26,0 fathoms	1.41535

When an object, whose elevation above the horizon is to be determined, is at a very great distance, it will be necessary to notice the correction arising from the curvature of the earth and the refraction, and apply that correction to the height estimated by the above method. Thus if the angular elevation of a mountain whose base was more distant than the limit of the visible horizon, was observed by an instrument of reflection; the approximate height must first be obtained, as in the preceding example, and then the correction of that approximate height for the curvature of the earth, refraction, and dip, must be calculated by the following rule, and added to that height, the sum will be the true height above the level of the sea.

Rule. Find in Table X. the number of miles corresponding to the height of the observer above the level of the sea, and take the difference between that number and the distance of the mountain from the observer in statute miles; with that difference enter the same table and find the height in feet corresponding, which will be the correction to be added to the approximate height to obtain the true height of the mountain above the level of the sea.

Example. Suppose the distance was 32 statute miles (or 168960 feet) and the observed altitude 1° 2′, the observer being 18 feet above the level of the sea. Required the height of the mountain above the same level?

As radius			10.00000
Is to distance 168960		log.	5.22779
So is elevation 1° 2′ tang.			8.25616
Approx. height	3048	log.	3.48395
Correction	398		
Sum	3446	is the true height above the level of the sea.	

	M.
Dist. of mountain	32
Tab. X. 18 feet	5,61
Difference	26,39
Corresponding Corr. Tab. X.	398ft.

PROBLEM VIII.

Sailing towards Cape-Cod, I discovered the light-house just appearing in the horizon, my eye being elevated 20 feet above the sea ; it is required to find the distance of the light-house, supposing it to be elevated 200 feet above the surface of the sea ?

The solution of this problem depends on the uniform curvature of the sea, by means of which all terrestrial objects disappear at certain distances from the observer. These distances may be computed by means of Table X. in which the elevation in feet is given in one column, and the distance at which it is visible, is expressed in statute miles in the other column. If the place from which you view the object be elevated above the horizon, you must *add together the distances corresponding to the height of the observer and the height of the object*, the sum will be the greatest distance at which that object is visible from the observer.

In the present example the height of the observer was 20 feet, and the height of the object 200 feet.

In Table X. opposite 20 feet is 5,92 miles.
200 feet 18,71

Distance 24,63 statute miles of about 69½ to a degree, the distance in nautical leagues, of 20 to a degree, being about 7.

PROBLEM IX.

A man being on the main-top-gallant-mast of a man of war, 200 feet above the water, sees a 100 gun ship she had engaged the day before, hull to ; how far were those ships distant from each other ?

A ship of 100 guns or a first rate man of war, is about 60 feet from the keel to the rails, from which deduct about 20, leaves 40 for the height of her quarter-deck above water. Now a ship is seen hull to when her upper works just appear.

In Table X. opposite 200 feet stand 18.71
40 feet 8.37

Distance 27.08 miles.

PROBLEM X.

Upon seeing the flash of a gun, I counted 30 seconds by a watch before I heard the report : How far was that gun from me, supposing that sound moves at the rate of 1142 feet per second ?

The velocity of light is so great, that the seeing of any act done even a number of miles distance, is instantaneous ; but by observation it is found that sound moves at the rate of 1142 feet per second, or about one statute mile in 4.6 seconds ; consequently the number of seconds elapsed between seeing the flash and hearing the report, being divided by 4.6 will give the distance in statute miles. In the present example the distance was about 6½ miles, because 30 divided by 4,6 quotes 6½ nearly.

PROBLEM XI.

To find the difference between the true and apparent directions of the wind.

Suppose that a ship moves in the direction CB from C to B, while the wind moves in its true direction from A to B, the effect on the ship will be the same as if she was at rest and the wind blew in the direction AC with a velocity represented by AC, the velocity of the ship being represented by BC. In this case the angle BAC will represent the difference between the true and apparent directions of the wind ; the apparent being more a-head than the true, and the faster the vessel goes the more a-head the wind will appear to be. We must, however, except the case where the wind is directly aft, in which case the direction is not altered.

It is owing to the difference between the true and appa-

rent directions of the wind, that it appears to shift its direction by tacking ship; and if the difference of the directions be observed when on different boards (the wind on both tacks being supposed to remain constant, and the vessel to have the same velocity and to sail at the same distance from the wind) the half difference will be equal to the angle BAC; by knowing which, together with the velocity of the ship BC, and the angle BCA, we may obtain the true velocity of the wind; or, by knowing the velocity of the wind and of the ship, and the apparent direction of the wind, we may calculate the difference between the true and apparent directions of the wind.

Thus if the velocity of a ship represented by BC be 7 miles per hour, that of the wind represented by AB 27 miles per hour, and the angle of the vessel's course with the apparent direction of the wind BCA=7½ points; the difference between the true and apparent directions of the wind would be obtained by drawing the line BC=7 miles taken from any scale of equal parts and making the angle BCA=7½ points, then with an extent equal to 27 miles, taken from the scale, and with one foot in B describe an arch to cut the line AC in A, join AB; then the angle BAC being measured, will be the sought difference between the true and apparent directions of the wind.

BY LOGARITHMS.

As AB	27 miles	log. ar. co.	8.56864
Is to BCA	7½ points	log. sine	9.99790
So is BC	7 miles	log.	0.84510
To BAC	14° 57′	log. sine	9.41164

So that in this case the difference between the true and apparent directions of the wind is about 1¼ points, and by tacking ship and sailing on the other board as above mentioned, the wind would appear to change its directions above 2½ points.

PROBLEM XII.

To measure the height of a mountain by means of the heights of two barometers taken at the top and bottom of the mountain.

Procure two barometers with a thermometer attached to each of them, in order to ascertain the temperature of the mercury in the barometers, and two other thermometers of the same kind to ascertain the temperature of the air. Then one observer at the top of the mountain, and another at the bottom, must observe at the same time the heights of the barometers and the thermometers attached thereto, and the heights of the detached thermometers, placed in the open air, but sheltered from the sun. Having taken these observations, the height of the upper observer above the lower may be determined by the following rule, which is adapted to a scale of English inches and to Fahrenheit's thermometer.

Rule. Take the difference of the logarithms of the observed heights of the barometer at the two stations, considering the first four figures, exclusive of the index, as whole numbers, the remainder as decimals; to this difference must be applied the product of the decimal 0,454, by the difference of the altitudes of the two attached thermometers, by subtracting if the thermometer was highest at the lowest station, otherwise adding; the sum or difference will be the approximate height in English fathoms. Multiply this by the decimal 0,00244, and by the difference between the mean of the two altitudes of the detached thermometers and 32°, the product will be a correction to be added to the approximate height when the mean altitude of the two detached thermometers exceeds 32°, otherwise subtracted; the sum or difference will be the true height of the upper above the lower observer in English fathoms, which multiplied by 6 will be the height in feet.

EXAMPLE.

Suppose the following observations were taken at the top and bottom of a mountain. Required its height in fathoms?

	Attached therm.	Detached therm.	Barometer.	
Obs. at lower station	57°	56°	29,68 inch.	log. 14724,6
Upper station	43	42	25,23	log. 14027,3
Difference	14	Mean 49	Difference	696,8
		32	0,454 × 14	6,4
		Diff. 17	Approx. height	690,4
			690,4 × 17 × 0,00244	28,6
			Height in fath.	719,0

MENSURATION.

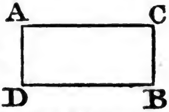
PROBLEM I.

To find the area of a Parallelogram.

RULE.

MULTIPLY the base by the perpendicular height, the product will be the area.

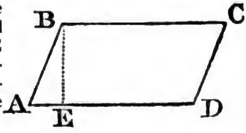
Note. If both dimensions are given in feet, inches, &c. the product will be the area expressed in square feet, square inches, &c. respectively; if one of the dimensions be given in feet and the other in inches, the product divided by 12 will be the answer in square feet; if both dimensions are given in inches, the product will be square inches, which divided by 144 will be the answer in square feet. The same is to be understood in finding the area of other surfaces.



Example I. Suppose the base DB of the rectangular parallelogram ACBD is 7 feet, and the perpendicular BC 3 feet; required the area? The product of the base 7 feet by the perpendicular 3 feet gives the area 21 square feet.

Example II. Suppose ACBD is a board whose length DB is 22 feet and breadth BC is 14 inches; required the number of square feet? The product of the base 22 feet by the breadth 14 inches is 308, this divided by 12 gives 25 square feet, the sought area.

Example III. If DB be 25 inches and BC 20 inches; required the area in square feet? The product of the base 25 inches by the perpendicular 20 inches gives 500, which divided by 144 gives the area 3,47 or 3 $\frac{47}{100}$ square feet.

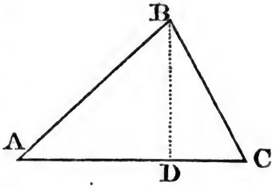


Example IV. Given the base AD of the oblique angular parallelogram ABCD, equal to 30 feet, and the perpendicular height BE 15 feet; required the area of the parallelogram? Multiply the base 30 feet by the perpendicular 15 feet; the product 450 is the area in square feet.

PROBLEM II.

To find the area of a Triangle.

Rule. Multiply the base by half the perpendicular height, and the product will be the area required.

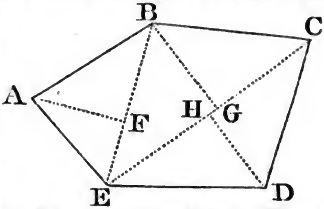


Example. Given the base AC 30 feet, and the perpendicular DB 20 feet, required the area of the triangle? The base 30 multiplied by half the perpendicular 10 gives the area 300 square feet.

PROBLEM III.

To find the area of any irregular right-lined figure.

Rule. Reduce the figure to triangles by drawing diagonals therein; then find the area of each triangle, and the sum of them will be the area of the proposed figure. Or, instead of finding the area of each triangle separately, you may find at one operation the area of two triangles having the same diagonal by multiplying the diagonal by half the sum of the perpendiculars let fall thereon.



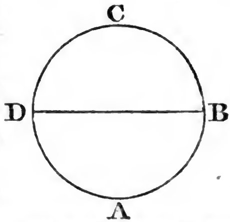
Example. Required the area of the figure ABCDE, in which EC=33 feet, EB=22 feet, and the perpendicular AF=13 feet, BG=14 feet, and DH=12 feet? The diagonal EB, 22 feet, multiplied by half the perpendicular AF, 6.5 feet, gives the area of the triangle AEB, 143 square feet; and the diagonal EC, 33 feet, multiplied by half the sum of the perpendiculars BG DH, 13 feet, gives the area of the figure BCDE, 429 feet; this added to the triangle AEB 143 feet, gives the whole area 572 square feet.

PROBLEM IV.

To find the area of a circle.

Rule. Multiply the square of the diameter of the circle by the quantity 0.7854, and you will have the sought area.

Note. Instead of multiplying by 0.7854 you may multiply by 11 and divide by 14, the quotient will be the area nearly. This quantity .7854 represents the area of a circle whose diameter is 1. The circumference of the same circle being 3.1416 nearly. The proportion of the diameter to the circumference is expressed in whole numbers by the ratio of 7 to 22 nearly; or more exactly by 113 to 355.*



EXAMPLE.

Required the area of a circle ABCD, whose diameter BD is 10.6 feet?

The diameter 10.6 multiplied by itself and by .7854 gives the sought area 88.247544 square feet.

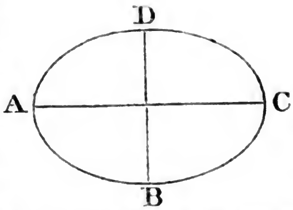
PROBLEM V.

To find the area of an Ellipsis or Oval.

Rule. Multiply the longest diameter by the least, and the product by

* This ratio may be easily remembered by observing that if the first three odd numbers 1, 3, 5, are repeated twice, they will produce the quantity 113355; the three first figures of which make the first term of the ratio, and the three last the last term of the ratio.

.7854, this last product will be the area required.



EXAMPLE. Required the area of an Ellipsis or Oval ABCD, whose longest diameter AC is 12 feet, and the shortest diameter BD 10 feet?

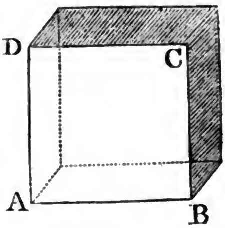
The product of the two diameters is $12 \times 10 = 120$, this multiplied by .7854 gives the sought area 94.2480 square feet.

The area of a sector of a circle may be found by means of the whole area of the circle obtained in Problem IV. by saying, as 360 degrees is to the angle contained between the two legs of the sector, so is the whole area of the circle to the area of the sector.

There are various regular solids, the most noted are the following.—(1) A *Cube*, which is a figure bounded by six equal squares. (2) A *Parallelepiped* which is a solid terminated by six quadrilateral figures, of which the opposite ones are equal and parallel. (3) A *Cylinder*, which is a figure formed by the revolution of a rectangular parallelogram about one of its sides. (4) A *Pyramid*, which is a solid decreasing gradually from the base till it comes to a point. There are various kinds of Pyramids according to the figure of their bases: thus if the base be a triangle, the solid is called a *triangular pyramid;* if a parallelogram, a *parallelogramic pyramid;* and if a circle, a circular pyramid, or simply a *Cone*. The point in which the pyramid ends, is called the *Vertex*, and a line drawn from the vertex perpendicular to the base is called the height of the pyramid.

PROBLEM VI.

To find the solidity of a Cube.



RULE. Multiply the length of a side of the Cube by that length, and that product by the same length, and you will have the solidity required; which will be expressed in cubic feet if the dimensions were given in feet; but in cubic inches if the dimensions were given in inches, &c.

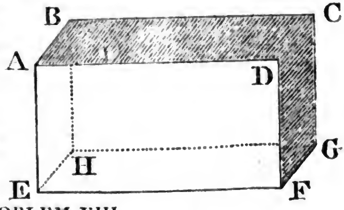
EXAMPLE. If the side AB of the cube of 6.3 feet it is required to determine the solidity?

The product of 6.3 by 6.3 is 39.69, this multiplied again by 6.3 gives the solidity 250.047 cubic feet.

PROBLEM VII.

To find the solidity of a Rectangular Parallelepiped.

RULE. Multiply the length, breadth and depth, into each other; the product will be the solidity required.



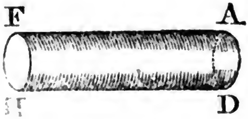
EXAMPLE. Suppose in the parallelepiped ABCDFGHE, the length EF is 36 feet, the breadth GF 16 feet, and the depth FD 12 feet; it is required to find the solidity?

The product of the length 36 by the breadth 16 is 576, this multiplied by the depth 12 gives the solidity 6912 cubic feet.

PROBLEM VIII.

To find the solidity of a Cylinder.

RULE. Multiply the square of the diameter of the base by the length and this product by the constant quantity .7854; this last product will be the solidity required.



Example. Required the solidity of a cylinder ADHF, whose length, HD is 13 feet, and diameter of the base AD is 11 feet?

The diameter 11 multiplied by itself and by the length 13 gives 1573, which multiplied by 0.7854 gives the solidity in cubic feet 1235.4342.

PROBLEM IX.

To find the solidity of a Grindstone.

Grindstones in the form of cylinders are sold by the *stone* of 24 inches diameter and 4 inches thick; the number of stones that any one contains may be obtained by the following rule.

Rule. Multiply the square of the diameter in inches by the thickness in inches, and divide the product by 2304, and you will have the number of *stones* required.

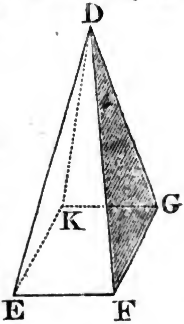
Example. Required the number of *stones* in a grindstone whose diameter is 36 inches and thickness 8 inches?

The square of the diameter 36 is 1296, which multiplied by the thickness 8 gives 10368. This divided by 2304 gives 4.5 or $4\frac{1}{2}$ stones, the solidity required.

This Problem may be solved by means of the line of numbers on Gunter's Scale, in a very expeditious manner, by the following rule.

Rule. Extend from 48 to the diameter, that extent turned over twice the same way, from the thickness, will reach to the number of stones required.

Thus in the preceding example, the extent from 48 to the diameter 36, turned over twice, from the thickness 8, will reach to 4.5, or $4\frac{1}{2}$, which is the number of stones sought.



PROBLEM X.

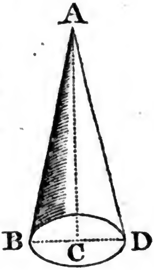
To find the solidity of any Pyramid or Cone.

Rule. Multiply the area of the base by one third of the perpendicular height of the Pyramid or Cone, the product will be the solidity required.

Example I. If the Pyramid has a square base, the side of which is 4 feet, and the perpendicular height 6 feet; it is required to determine the solidity?

The area of the base is $4\times4=16$ square feet, this multiplied by one third of the height or 2 feet gives 32 feet the solidity required.

Example II. If the diameter of the base of a cone be 10,6 feet, and the perpendicular height 30 feet; it is required to find the solidity?



The area of this base was found in Problem IV. equal to 88,247544; this multiplied by one third of the height or 10 feet, gives the solidity required equal to 882,47544 cubic feet.

Having obtained, by the foregoing rules, the number of cubic feet in any body, you may find the corresponding number of tons by dividing the number of cubic feet by 40, which is the number of cubic feet contained in one ton. Thus the solidity of the abovementioned cone 882,47544, being divided by 40, quotes 22,061886, which is the number of tons in that cone.

PROBLEM XI.

To find the tonnage of a ship.

By a law of the congress of the United States of America, the tonnage of a ship is to be found in the following manner.

If the vessel be double-decked, take the length thereof from the fore part of the main stem to the after part of the stern-post above the upper deck; the breadth thereof at the broadest part above the main wales, half of which breadth shall be accounted the depth of such vessel; then deduct from the length three-fifths of the breadth, multiply the remainder by the breadth, and the product by the depth; divide this last product by ninety-five, and the quotient will be the true content or tonnage of such vessel.

If the vessel be single-decked, take the length and breadth as above directed, in respect to a double-decked vessel, and deduct from the length three-fifths of the breadth, and taking the depth from the under side of the deck plank to the ceiling of the hold; multiply and divide as aforesaid, the quotient will be the true content or tonnage of such vessel.

Example. Suppose the length of a double-decked vessel is 80 feet, and the breadth 24 feet, what is her tonnage? Three-fifths of the breadth 24 feet, is 14.4 feet, which, subtracted from the length 80 feet, leaves 65.6. This multiplied by the breadth 24 feet gives 1574.4, this multiplied by the depth 12 feet (half of 24) gives 18892,8, which divided by 95 quotes the tonnage 198.8.

Carpenters, in finding the tonnage, multiply the length of the keel by the breadth of the main beam and the depth of the hold in feet, and divide the product by 95; the quotient is the number of tons. In double-decked vessels half the breadth is taken for the depth.

GAUGING.

HAVING found the number of cubic inches in any body by the preceding rules, you may thence determine the content in gallons, bushels, &c. by dividing that number of cubic inches by the number of cubic inches in a gallon, bushel, &c. respectively.

A *wine gallon*, by which most liquors are measured, contains 231 cubic inches. A *beer gallon*, by which beer, ale, and a few other liquors are measured, contains 282 cubic inches. A *bushel* of corn, malt, &c. contains 2150.4 cubic inches: this measure is subdivided into 8 gallons, each of which contains 268.8 cubic inches.

In all the following rules, it will be supposed that the dimensions of the body are given in inches, and decimal parts of an inch.

PROBLEM I.

To find the number of gallons or bushels in a body of a cubic form.

Rule. Divide the cube of the sides by 231, the quotient will be the answer in wine gallons; or by 282 and the quotient will be the answer in beer gallons; or by 2150.4, and the quotient will be the number of bushels.

Example. Required the number of wine gallons contained in a cubic cistern, the length of whose side is 62 inches? Multiplying 62 by itself and the product again by 62, gives the solidity 238328; which divided by 231 gives the content 1031$\frac{17}{21}$ wine gallons.

PROBLEM II.

To find the number of gallons or bushels contained in a body of the form of a rectangular Parallelepiped. See the figure of Problem VII. of Mensuration.

Rule. Multiply the length, breadth, and depth together; divide this last product by 231, for wine gallons; by 282 for beer gallons; and by 2150.4 for bushels.

Example. Required the number of wine gallons contained in a cistern ABCDFGHE (see fig. Prob. VII. of Mensuration) of the form of a parallelepiped, whose length EF is 66 inches, its breadth GF 35 inches, and its depth FD 24 inches. Multiplying the length 66 by the breadth 35 gives 2310, this multiplied by the depth 24, gives the solidity 55440; which divided by 231 quotes 240 wine gallons.

PROBLEM III.

To find the number of gallons or bushels contained in a body of a cylindrical form.

RULE. Multiply the square of the diameter by the height of the cylinder, and divide the product by 294.12, the quotient will be the number of wine gallons; if you divide by 359.05 the quotient will be the number of ale gallons; and if you divide by 2738, the quotient will be the number of bushels.

NOTE. These divisors are found by dividing 231, 282, and 2150.4 by .7854.

EXAMPLE. Required the number of wine gallons contained in the cylinder AFHD (See the fig. of Prob. VIII. of Mensuration) the diameter AD of its base being 26 inches, and length HD 18 inches? The diameter 26 multiplied by itself gives 676, this multiplied by the length 18, gives the solidity 12168, which divided by 294.12, gives the answer 41 wine gallons.

PROBLEM IV.

To find the number of gallons or bushels contained in a body of the form of a pyramid or cone. (See figures of Problem X. of Mensuration.)

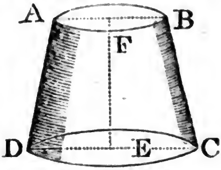
RULE. Multiply the area of the base of the pyramid or cone by one-third of its perpendicular height; the product divided by 231 will give the answer in wine gallons; if divided by 282, the quotient will be the number of beer gallons; and if divided by 2150.4, the quotient will be the number of bushels.

EXAMPLE. Required the number of beer gallons contained in a pyramid DEFGK (See fig. Prob. X. Example I.) whose base is a square EFGK, a side of which, as EF, is equal to 30 inches, and the perpendicular height of the pyramid is 60 inches? The square of 30 is the area of the base 900, this multiplied by one-third of the altitude 20, gives the solidity 18000, which divided by 282, gives the answer in beer gallons 63.8.

PROBLEM V.

To find the number of gallons or bushels contained in a body of the form of a frustrum of a cone. (See the figure below.)

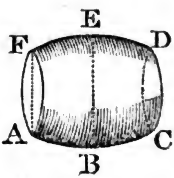
RULE. Multiply the top and bottom diameters together, and to the product add one-third of the square of the difference of the same diameters; multiply this sum by the perpendicular height, and divide the product by 294.12 for wine gallons, by 359.05 for ale gallons, and by 2738 for bushels.



EXAMPLE. Given the diameter DC of the bottom of a frustrum of a cone 36 inches, the top diameter AB=27 inches, and the perpendicular height, FE 50 inches. Required the content in wine gallons? The product of the two diameters 36 and 27 is 972; their difference is 9, which squared and divided by 3 gives 27; this added to 972 gives 999, which multiplied by the height 50 gives the solidity 49950; this divided by 294.12 quotes the content in wine gallons 169.

PROBLEM VI.

To gauge a cask.



To gauge a cask, you must measure the head diameters FA, DC, and take the mean of them when they differ; measure also the diameter EB at the bung, (taking the measure within the cask); then measure the length of the cask, making due allowance for the thickness of the heads. Having these dimensions, you may calculate the content in gallons or bushels, by the following rule.

RULE. Take the difference between the head and bung diameters, multiply this by .62 and add the product to the head diameter, the sum will be the mean diameter; multiply the square of this by the length of the cask, and divide the product by 294.12 for wine gallons, by 359.05 for beer gallons, and by 2738 for bushels.

The quantity .62 is generally used by gaugers in finding the mean diameter of a cask; but if the staves are nearly straight, it would be more accurate to take 55 or less;* if, on the contrary, the cask is full on the quarter, it would be best to take .64 or .65.

EXAMPLE. Given the bung diameter EB=34.5 inches, the head diameter FA=DC=30.7 inches, and the length 59.3 inches; required the number of wine gallons this cask will hold? The difference of the two diameters 34.5, and 30.7, is 3.8; this multiplied by .62 gives 2.4 nearly, to be added to the head diameter 30.7 to obtain the mean diameter 33.1. The square of 33.1 is 1095.61, this multiplied by the length 59.3 gives the solidity 64969.673, which, divided by 294.12, quotes the content in wine gallons 220.8.

To gauge a cask by means of the line of numbers on Gunter's Scale, or on the calipers used by gaugers.

Make marks on the scale at the points 17.15, 18.95, and 52.33, which numbers are the square roots of 294.12, 359.05, and 2738, respectively. A brass pin is generally fixed on the calipers at each of these points, which are called the gauge points. Having prepared the scale in this manner, you may calculate the number of gallons or bushels by the following

RULE. Extend from 1 towards the left hand to .62, (or less if the staves be nearly straight) that extent will reach from the difference between the head and bung diameters, to a number to the left hand, which added to the head diameter will give the mean diameter; then put one foot of the compasses upon the gauge point—which is 17.15 for wine gallons, 18.95 for ale gallons, and 52.33 for bushels—and extend the other to the mean diameter; this extent turned over twice the same way, from the length of the cask, will give the number of gallons or bushels respectively.

In the preceding example the extent from 1 to .62 will reach from 3.8 to 2.4 nearly, which added to 30.7 gives the mean diameter 33.1.

Then the extent from the gauge point 17.15 to 33.1, turned over twice from the length 59.3, will reach to 220.8 wine gallons.

If you had used the gauge point 18.95, the answer would have been in ale gallons; and if you had used 52.33, the answer would have been in bushels.

SURVEYING.

LAND is generally measured by a chain of 66 feet in length, divided into 100 equal parts called links, each *link* being 7.92 inches.

A *pole* or *rod* is 16½ feet, or 25 links, in length; hence a square pole contains 272¼ square feet, or 625 square links.

An *acre* of land is equal to 160 square poles, and therefore contains 43560 square feet, or 100,000 square links.

To find the number of square poles in any piece of land, you may take the dimensions of it in feet, and find the area in square feet, as in the preceding Problems; divide this area by 43560, the quotient will be the number of acres: or by 272.25, and the quotient will be the number of square poles. If the dimensions be taken in links, and the area be found in square links, you may obtain the number of acres by dividing by 100000 (that is, by crossing off

* In the example to Problem V. preceding (which may be esteemed as the half of a hogshead with staves perfectly straight) the multiplier is only .51. For this multiplied by 9, the difference between AB and DC, produces 4.59 or 4.6 nearly, which, added to 27, and the sum 31.6 squared, multiplied by 50 and divided by 294.12 quotes 169 gallons nearly.

the five right hand figures;) and the number of square poles may be obtained by dividing by 625.

PROBLEM I.

To find the number of acres and poles in a piece of land in the form of a rectangular parallelogram.

RULE. Multiply the base by the perpendicular height, and divide by 625, if the dimensions were taken in links, but by 272.25, if they were taken in feet; the quotient will be the number of poles, which, divided by 160, will give the number of acres.

EXAMPLE I. Suppose the base DB (see the figure of Ex. I. Prob. I. of Mensuration) of the rectangular parallelogram ACBD is 60 feet, and the perpendicular BC 25 feet; required the area in poles?

The product of the base 60 by the perpendicular 25 gives the content 1500 square feet, and by dividing by 272,25, we obtain the answer in square poles 5.5.

PROBLEM II.

To find the number of acres and poles in a piece of land in the form of an oblique-angular parallelogram. (See the figure of Prob. I. Ex. IV. of Mensuration.)

RULE. This area may be found in exactly the same manner as in the preceding Problem, by multiplying the base AD by the perpendicular height BE, and dividing by 625, when the dimensions are taken in links, but by 272.25 when taken in feet; the quotient will be the answer in poles, which divided by 160 will give the answer in acres.

EXAMPLE. Suppose the base AD is 632 links, and the perpendicular BE 326 links; required the number of poles?

Multiply the base 632 links by the perpendicular 326 links, the product 206032 divided by 625, gives the answer in poles 329.

PROBLEM III.

To find the number of acres and poles in a piece of land of a triangular form.

RULE. Multiply the base by the perpendicular height, and divide the product by 1250 when the dimensions are given in links, but by 544.5 when they are given in feet; the quotient will be the answer in poles.

NOTE. Instead of dividing by 1250, you may multiply by 8, and cross off the four right hand figures.

EXAMPLE. Given the base AC (see fig. of Prob. II. of Mensuration) equal to 300 feet, and the perpendicular BD 150 feet; required the area in poles?

Multiply the base 300 by the perpendicular 150, the product 45000, divided by 544.5, quotes the answer in poles 82.6.

PROBLEM IV.

To find the number of acres and poles in a piece of land of any irregular right-lined figure.

RULE. Find the area as in Problem III. of Mensuration, by drawing diagonals, and reducing the figure to triangles: the base of each triangle being multiplied by the perpendicular, (or by the sum of the perpendiculars falling on it) and the sum of all these products divided by 1250 when the dimensions are given in links, but by 544.5 when in feet, will give the area of the figure in poles.

EXAMPLE. Suppose that the piece of land is of the same form as the figure in Prob. III. of Mensuration, and that EB=22 feet, EC=33 feet, AF=13 feet, BG=14 feet, and DH=12 feet: it is required to find the area in poles?

The product of EB 22 feet, by AF 13 feet, gives double the triangle EAB 286 square feet; and the diagonal EC 33 feet, multiplied by the sum of the perpendiculars BG, DH, 26 feet, gives double the figure BCDE, 858 square feet; the sum of this and 286, divided by 544.5 gives the area 2,1 or $2\frac{1}{10}$ poles.

To find the content of a field by the Table of difference of Latitude and Departure.

This method is simple and much more accurate than by projection, the boundaries being straight lines, whose bearings and lengths are known. The rule for making these calculations is as follows.

RULE.

1. Begin at the western point of the field, as at the point A in the figure Prob. III. of Mensuration, for a point of departure; and mark down in succession the bearings and lengths of the boundary lines AB, BC, &c. as courses and distances in a traverse table. Find the corresponding differences of latitude and departure by Table I. or II. (or by logarithms) and enter them in their respective columns N. S. E. W. as in the adjoined Table.

2. Find the departures or meridian distances of the points B, C, &c. from the point A, by adding the departures when east, but subtracting when west, and mark them respectively against the bearings, in the column of meridian distance.

3. Place in the first line of the column M the first meridian distance 16.1, and in the following lines, the sum of the meridian distance which stands on the same line and that immediately above it. Thus on the second line I put 52.1 which is equal to the sum of 16.1 and 36.0. On the third line 66.2=36.0+30.2, &c.

Courses	Dis.	N.	S.	E.	W	Mer Dis	M.	North Areas.	South Areas.
N. 58° E.	19.	10.1		16.1		16.1	16.1	162.61	
E. 6 S	20.		2.1	19.9		36.0	52.1		109.41
S 17 W.	20		19.1		5.8	30.2	66.2		1264.42
W.	20.				20.0	10.2	40.4		0
N. 42° 35′ W	15.1	11.1			10.2	0.0	10.2	113.22	
		21.2	21.2	36	36.0			275.83	1373.83
									275.83
									1098.
								Half.	549.

4. Multiply the numbers in the column M by the differences of latitude in the same horizontal line, and place the product in the column of areas marked north or south, according as the difference of latitude is north or south. Thus in the first number in the column M is 16.1 which multiplied by the corresponding difference latitude 10.1 N. produces the north area 162.61. The second value of M, 52.1, multiplied by the second difference of latitude 2.1 S. produces the south area 109.41. The third values 66.2 and 19.1 S. produces the south area 1264.42. The fourth difference of latitude is 0, which multiplied by the fourth meridian distance 40.4 produces 0 for the corresponding area, which is the case whenever the bearing is east or west, &c.

5. Add up all the north and all the south areas; half their difference will be the area of the field in square measures of the same name as those made use of in measuring the lines, whether feet, links, or chains, &c. Thus the sum of all the north areas is 275.83, the south 1373.83; their difference is 1098, half of which is 549 square feet the area of the given field.

It may be observed that the bearings and lengths of the boundary lines in this example are not exactly the same as those in Problem III. of Mensuration, which is the reason of the difference in the area above calculated and that found in Problem III. by dividing the field into triangles.

If it had been thought necessary, the differences of latitude and departure might have been taken to one decimal place farther, by entering the table with ten times the length 19, 20, &c. and taking one-tenth of the corresponding differences of latitude and departure.

In the above calculations we have supposed the survey to have been made with accuracy, in which case the sums of the differences of latitude in the columns N. S. ought to be equal to each other, also the sums of the departures in the columns E. W. This is the case in the above example where

the sum of the Diff. of Lat. is 21.2, and the sum of the departure 36.0: but it more frequently happens that the numbers do not agree; in which case the work ought to be carefully examined, and if no mistake can be found, and the error is great, the place ought to be surveyed again; but if the error be small, it ought to be apportioned among all the differences of latitude and departure, in such manner as to produce the required correction with the least possible changes in the given numbers. The method of doing this was explained by me in the fourth number of the Analyst, in answer to a prize question of Professor Patterson, and is as follows. Find the error in latitude, or the difference between the sums of southing and northing, also the sum of the boundary lines, AB, BC, &c. Then say, as this sum is to the error in latitude, so is the length of any particular boundary to the correction of the corresponding difference of latitude, additive if in the column whose sum is the least, otherwise subtractive. The corrections of the departure are found by the same rule, except changing diff. of lat. into departure. Thus in the adjoined example, the sum of the boundary lines is 161.6, the error of latitude is 0.10 and of departure .08,

Bearings.	Lengths	N.	S.	E.	W.	Corrections.		Corrected values.			
						N.	E.	N.	S.	E.	W.
N. 45° E.	40.	28.28		28.28		.02	.02	28.30		28.30	
S. 30 W.	25.		21.65		12.50	.02	.01		21.63		12.49
S. 5 E.	36.		35.86	3.14		.02	.02		35.84	3.16	
W.	29.6				29.60	.02	.01	0.02			29.59
N. 20 E.	31.	29.13		10.60		.02	.02	29.15		10.62	
	161.6	57.41	57.51	42.02	42.10	.10	.08	57.47	57.47	42.08	42.08
			57.41		42.02						
		Error	.10	Error	.08						

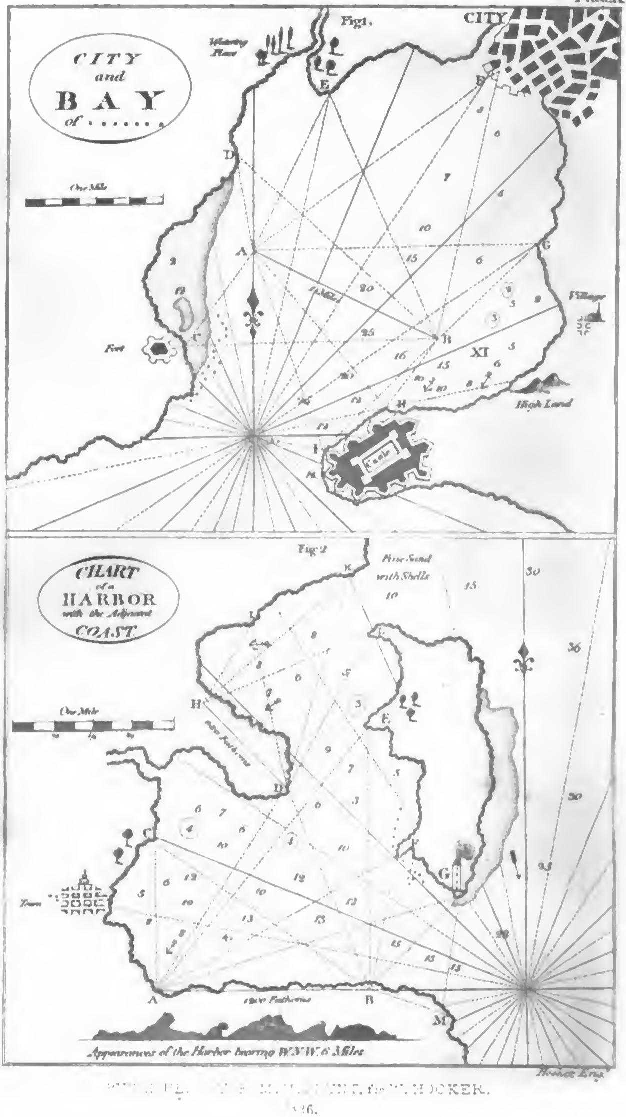
and the corrections of the diff. of lat. and departure are found by the following proportions:

Lat.	Dep.
161.6 : 0.10 : : 40 : 0.02*	16.16 : 0.08 : : 40 : 0.02
: : 25 : 0.02	: : 25 : 0.01
: : 36 : 0.02	: : 36 : 0.02
: : 29.6 : 0.02	: : 29.6 : 0.01
: : 31 : 0.02	: : 31 : 0.02

The first correction of lat. .02 is to be added to the first latitude, 28.28, because it is in the column whose sum 57.41 is less than the other 57.51, so that the first corrected diff. of lat. is 28.30. The second is the difference between 21.65, and the second correction .02, because 21.65 is in the greatest column, the corrected value is therefore 21.63. The third is found in the same manner to be 35.86—.02=35.84. The fourth corrected difference of latitude is simply the fourth correction .02 placed in the column N, because the sum in that column, 57.41 is the least and the fourth diff. of latitude in the original table is 0. The fifth is the sum of 29.13 and the fifth correction 0.02, making 29.15. These are placed in their proper columns in the corrected values. In a similar manner the first departure is equal to the sum of 28.28 and the first correction 0.02, which is equal to 28.30. The second is the difference between 12.50 and the second correction .01, making 12.49; and so as for the others, taking the sum when the departure is in the column whose sum is the least, which in the present case is the east, and the difference when in the other column. In the traverse table thus corrected, the sum of the differences of latitude is 57.47 in both columns, and the sum of the departures 42.08. Having corrected the values of this traverse table, you must find the meridian distances, the column M, the north and south areas, &c. as in the former example.

* The boundary lines in this example are so nearly of an equal length that the correction of the difference of latitude (taken to the nearest decimal) is 0.02 for each of them, but in general, they will be different. The table of difference of latitude and departure may be made use of in finding these corrections, thus: seek in the table till the first term 161.6 (or 162) is found in the distance column to correspond to the second term .10 (or 10) in the departure column, thus opposite the third term 40, 25, 36, &c. will be the sought corrections, as is evident.

Plate X.



Hooker Eng.

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In projecting a survey of this kind, where there is a small error, you must plot off as usual the boundary lines AB, BC, CD, &c. and it will be found that the termination of the last line EA will not fall exactly in the point A, but will be at a point near it, which we shall call *a*. To correct this error you must draw through the points B, C, D, &c. lines parallel to *a*A, in the direction from *a* to A, of such lengths as to be to A*a*, as the distances of those points respectively from A (measured on the boundary ABCD, &c.) are to the whole length of the boundary line, through these points draw the corrected lines terminating on A. Want of room prevents entering into farther explanation of the subject.

The manner of surveying Coasts and Harbours.

From what has been said in the preceding problems, the intelligent reader will readily perceive the method of surveying a coast or harbour; but as this is an important subject, it was thought proper to enter more fully into an explanation of the different methods to be made use of.

To take a draught of a coast in sailing along shore.

Having brought the ship to a convenient place, from which the principal points of the coast, or bay, may be seen, either cast anchor, if it is convenient, or lie-to as steady as possible; or if the coast is too shoal, let the observations and measures be taken in a boat. Then while the vessel is stationary, take with an azimuth compass the bearings in degrees of such points of the coast as form the most material projections or hollows;* write down these bearings, and make a rough sketch of the coast, observing carefully to mark the points whose bearings are taken, with letters or numbers, for the sake of reference.

Then let the ship or boat run in a direct line, which must be very carefully measured by the log, or otherwise, one, two, or three miles, until she comes to a situation from which the same points before observed can be seen again with quite different bearings: then let the vessel lie steady as at the former station, and observe again the bearings of the same points, and make a rough sketch of the coast; this sketch may be made more accurately while the vessel is running the base line.

To describe the chart from these observations, you must in some convenient part of a sheet of paper draw the magnetic meridian, and lay off the several bearings taken at the first station, marking them with their proper letters or numbers; lay down also the bearings taken from the second station. Draw a line to represent the ship's run both in length and course, and from that end of the line expressing the first station, draw lines parallel to the respective bearings taken from that end; also from the other end draw lines parallel to the bearings taken at that end, and note the intersection of each pair of lines directed to the same point; and through these intersections draw by hand a curved line, observing to wave it in and out as near as can be like the tending of the coast itself. Then mark off the variation of the compass from the north end of the magnetic meridian towards the right hand, if it be west, or towards the left hand if it be east, and draw the true meridian through that point and the centre of the circle.

Against each part draw the appearance of the land marked in the sketches, distinguishing the rocky shore, highland, beach, &c. as in Plate V. or XI. Thus the sand beaches may be marked as in Plate XI. fig. 8, and the rocky shore as in fig. 9, &c. Put in the several soundings at low water,† in small figures, distinguishing whether they are fathoms or feet; show the time of high water on the full and change days by Roman figures, and tell the rise of the tide in feet. The direction and velocity of the flood tide are to be observed, which may be done by heaving the log when the ship or boat is at

* In taking the bearings, if the vessel has much motion, the mean of several observations should be taken.

† If the soundings were not taken at low water, they may be reduced thereto by a method which will be explained hereafter.

anchor, and the direction is to be represented by an arrow. Put in a compass and a scale of miles or leagues such as the vessel's run was laid down by; add the name of the place, and the latitude and longitude as true as can be obtained.

If there are shoals or sands on the coast, let them be taken in a boat, sailing round them, keeping account of the courses, distances, and soundings.* But to put them in the draught, the observer in the boat must take the bearings of two points on the coast (the bearings of which have been taken from the ship) from some part of each sand or shoal, so sailed round; or, the bearing of the boat at some part of the shoal, or of some beacon in that place, must be taken by the ship at each of the stations where the bearings of the shore were taken from the ship; for by either of these means, one point of the sand being obtained, the rest of it can be laid down from the observations taken in the boat. Rocky shoals may be marked on the chart, as in Plate XI. fig. 11, and sand banks as in fig. 10.

If the coast to be drawn is a bay or harbour winding in such manner that all its parts cannot be seen at two stations, let as many bases or lines be run and measured exactly as may be found necessary, observing that the several distances run should join to one another, in the nature of a traverse; that each new set of objects, or points observed, should be taken from two stations at the ends of a known distance, and that the objects whose bearings are taken do not so much extend beyond the limits of the base as to make angles with it less than about ½ or ¾ of a point, but rather reserve such objects for the next measured base line; for, when lines lie very obliquely to one another, their intersections are not easily ascertained.

If any particular parts of the harbour cannot be conveniently seen from either of the stations, take the boat into those places, and having well examined them, made sketches thereof, estimating the lengths and breadths of the several inlets, either by the rowing or sailing of the boat, take as many bearings, soundings, and other notes, as may be thought necessary; then annex these particular views in their proper places, in the general draught.

If there are any dangerous sands or rocks, besides inserting them in their proper places, you must see if there be any two objects ashore (such as a church, mill, house, noted cliff, &c.) which appear in the same right line when on the shoal; and these objects must be noted on your chart. If none can be found, you must take the bearings of some remarkable points, and note them on your chart; by which means it will be known how to avoid the danger.

It should be remarked in the draught the kind of bottom obtained in sounding, whether mud, sand, shells, coral, rocky ground, &c.; and where there is good anchorage draw the figure of an anchor. Also, if there is any particular channel more convenient than another, it is to be pointed out by lines drawn to its entrance from two or more noted marks ashore.

The positions of objects taken by a magnetic compass being liable to great uncertainties, as is well known to those who have had any experience, especially at sea; it has therefore been recommended to observe only the bearings of the station lines by the compass, and then measure the angles which the other objects make with these lines, by a quadrant or sextant, which for this purpose must be held in an horizontal position.

EXAMPLE I. (See fig. 1, Plate X.

Suppose a ship at A observes the bearings of the most remarkable point of a bay, C, D, E, F, G, H, and I, and sails S. 64° E. 1½ miles to B; at B

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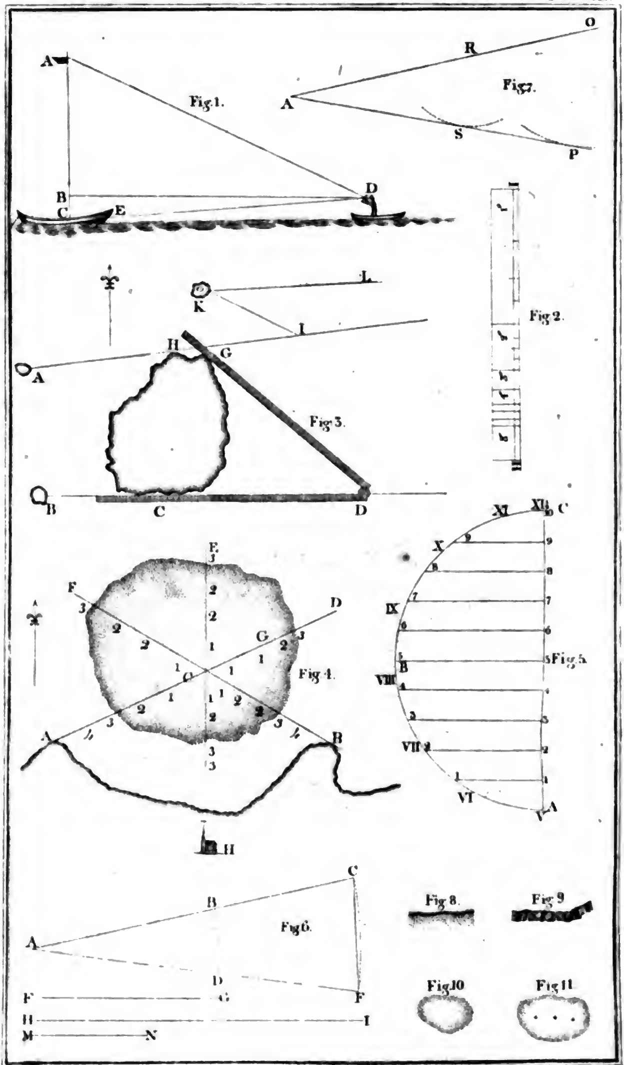
* It is difficult to ascertain correctly the courses and distances sailed by the boat, on account of the currents and other causes. This inconvenience may be obviated if the ship be at anchor, and not far from the boat, by observing in the boat the bearing of the ship by compass, and by measuring, with a quadrant, the angle contained between the top-gallant-mast head, and that part of the ship which is at the same height as the eye of the observer; for by this angle the distance of the boat from the ship may be determined, as will be explained in this work.



Hooker Eng.

1826.

she also observes the bearings of the same points; hence it is required to construct the chart.

Bearing of C from A	S. 36° W.		Bearing of C from B	S. 89° E.
D	N. 9° W.		D	N. 48° W.
E	N. 26° E.		E	N. 24° W.
F	N. 55° E.		F	N. 13° E.
G	East.		G	N. 47° E.
H	S. 40° E.		H	S. 38° W.
I	S. 19° E.		I	S. 46° W.

Draw the line AB, S. 64° E. 1¼ miles. Through the points A and B draw the lines AC, AD, AE, AF, AG, AH, AI, BC, BD, BE, BF, BG, BH, and BI, at their respective bearings, and where the corresponding lines cut each other, will be the points C, D, E, F, G, H, and I, required; through which the different curvatures of the land must be drawn, corresponding with your eye-draught. In this manner may a chart be constructed by observations taken upon the water. The manner of surveying upon land is exactly similar.

To survey a harbour by observations on shore.

Make an eye-draught of the place to be surveyed, and in going round the coast fix station staves, or straight poles, tall enough to be seen at a considerable distance, in the most remarkable points and bendings of the shore; but if at any of those places there is a noted tree, house, or any other remarkable thing, that object may serve instead of a station staff; and it will be convenient to black the staves, and tie a piece of white bunting at the top of each; then in the eye-draught put letters or numbers at the noted points or marks for the sake of distinction.

Choose the most extensive and level spot of ground you can meet with to measure your base line upon, which should not be less than a tenth part of the distance of the two extreme objects which are to be observed; and let the direction of the measured base line be such, that as many of the station staves as possible may be seen from each end of it. The bearing or position of this base must be well determined in degrees and minutes, and the length accurately measured, either by a measuring chain or a piece of log-line.

From each end of the base observe, with an azimuth compass, or with a Theodolite, if it can be procured, the bearings of each of the station staves; or else with a sextant measure the angles contained between the staves or remarkable objects, and the other end of the station line, and write them down in order in your book. These measures and angles being plotted down as before directed, will give the most conspicuous points of the shore, the intermediate spaces are to be filled up from the sketches made on the spot.

But if either of these objects should spread on either hand so far beyond the limits of the base, that at either end thereof the other end and those objects should appear nearly in the same direction, or to make angles not exceeding 10°: or, if some of the remarkable objects could be seen only from one end of the base; then let the bearings of such objects be taken from a place whose position has been determined from both ends of the measured base; or, if there are several remarked objects which cannot be seen from either end of the base lines, let the bearings of such objects be taken from each of two points whose positions have been determined by bearings taken from both ends of the base, or it may, on some occasions, be proper to choose another place on which another base of a convenient length may be measured, and from the extremities of which the ends of the first base may be seen; and as many as can be of the remaining objects which lay too obliquely, or which could not be seen from the first base. In such manner proceed until the bearings are taken of all the points judged necessary for completing the survey of the limits of the harbour.

If a right line of a sufficient length for a base line cannot be measured, it may be taken in two adjoining lines as the two sides of a triangle, the included angle being accurately taken, and the bearing of either line.

When the outlines or limits of a harbour, bay, road, &c. are delineated, by the preceding precepts, let a small vessel go out to sea to take drawings of the appearance of the land and its bearings; sail likewise into the harbour, and draw the appearance of its entrance; take particular notice if there be any false resemblance of the entrance, by which ships may be deceived and run into danger; or when any two objects being brought in a line, or in one, will lead into the harbour without danger; search for the best anchoring places, and if possible, denote those places by bringing two objects in one, if not, take the exact bearings of two or three other objects, so that the places may be easily determined. The chart being correctly drawn, a compass, with the variation, and scale properly fitted to the plan, the islands, rocks, sands, &c. must be marked in their proper places, with their soundings at low water, the anchoring places, with the best track to get to them; the proper sailing marks to avoid dangers; the places where fresh water can be got; the name of the place, the country in, on what sea; the latitude and longitude; a sketch of the appearance the place makes at sea upon a known bearing, and at an estimated distance; and whatever else a judicious seaman shall think proper may be inserted. Then will the plan be fit for all nautical purposes, and may be embellished with proper colours if necessary.

EXAMPLE II. (See fig. 2. Plate X.)

From each end of a base line AB of 1200 fathoms, were observed the points C, D, E, F, and G; and as the points I, K, and L, were not visible from the extremities of the base line, another base line was measured from the point D to H of 650 fathoms, from which points the bearings of I, K, and L, were observed: hence it is required to construct a chart of the place.

Bearing of	B from A	East.	Bearing of	C from B	N. W. b. W.
	C	North.		D	N. N. W.
	D	N. E. b. N.		E	North.
	E	N. E. ½ N.		F	N. b. E.
	F	N. E. b. E. ½ E.		G	N. E.
	G	E. b. N. ½ N.			
Bearing of	H from D	N. W.	Bearing of	I from H	N. E. by N.
	I	N. b. W.		K	N. E. ½ E.
	K	N. b. E. ½ E.		L	E. N. E.
	L	N. N. E. ½ E.			

Draw the east line AB=1200 fathoms; from each end of this line draw the lines AC, AD, AE, AF, AG, BC, &c. at their respective bearings; the points of intersection will give the points C, D, E, F, and G. From the point D (which was found in this manner) draw the N. W. line DH=650 fathoms: and through these points draw the lines DI, DK, DL, HI, &c. at their respective bearings; the points of intersection of the corresponding lines will be the situation of the points I, K, L. Between these remarkable points, draw the outlines of the land, conformable to your rough draught.

In order to determine the situation of the point M, which was seen too obliquely from the bases AB, DH, you may take the bearing of that point from B, and then from G (whose situation has been determined by bearings taken from the points A, B,) the intersection of the lines BM, GM, will determine the situation of M.

Method of surveying a small bank or shoal where great accuracy is required.

The method of determining the extent and situation of shoal ground by sailing round it and keeping an account of the courses and distances sailed, is well adapted to the taking of an extensive survey, or to the exploring of a large bank, where great accuracy is not required; but the difficulty of ascertaining with precision the courses and distances sailed (which are liable to error on account of the tides, currents, and the different velocity of the boat at different times owing to the unsteadiness of the wind) prevents this method from being sufficiently accurate to be used in exploring a dangerous shoal or bank at the entrance of a narrow channel of a harbour, or any other place where the exact form of the shoal is to be found; and if to ob-

tain the necessary degree of correctness, the bearings of two remarkable objects were taken at every time of sounding, the time expended in taking the observations would be increased beyond all reasonable bounds. To obviate these difficulties, the following methods may be made use of, by either of which the necessary observations for determining the situation of the boat, may be made as fast as the soundings can be taken.

First Method. Procure a large sail-boat with a high mast, and a small row-boat; bring the sail-boat to anchor on the bank which is to be explored, and take accurately the bearings of two remarkable points of land, or other objects whose situation has already been determined by observations taken on shore, or in sailing along the land; by this means the situation of the sail-boat may be accurately marked on the chart; then enter the small boat and row from the other in any particular direction, observing to keep the mast of the boat to bear upon any point of the compass, or (which is much more accurate) to keep the mast of the boat to range on any particular point of land, or other object marked on the chart; by these means any errors which might arise in the course of the boat will be entirely prevented. While proceeding in this direction let one person take the soundings, while another observes with a quadrant or sextant the angular elevation of the top of the boat's mast above the horizontal line drawn from the eye of the observer, and a third person notes the observations in the minute book, and the time of observation, in order to make the necessary reduction in the soundings to reduce them to low water. Proceed in this manner from the sail-boat till you get off the bank into deep water, or till the elevation of the mast is not much less than one degree, then row across the bank till the bearing of the mast is altered considerably, or till it appears in a range with another point of land at a considerable angular distance from the point with which the mast ranged in the first observations; then row towards the boat, sounding and observing the angular elevation of the mast as before. Proceed in this manner in sounding to and from the sail-boat till you have procured a sufficient number of soundings in every direction. Then go on board the sail-boat and shift her birth to another part of the bank where soundings have not been taken and proceed to sound as before. Continue sounding and shifting the situation of the boat, till the whole bank has been explored, and then the observations may be plotted off by the directions in the following example.

Let ABC (Plate XI. fig. 1.) be the mast of the sail-boat, D the situation of the eye of the person who observes the angular elevation of the mast. Draw the line DB parallel to the horizon and join DA. Then the height AB must be measured* accurately, and that being given and the observed angle ADB the corresponding distance BD may be obtained by the usual rules of trigonometry by saying as radius : AB : : co-tangent ADB : BD. Thus if the height AB was 30 feet, and the angle ADB 1°, the distance BD would be 1719 feet (being 57,3 times as great as AB). The distances corresponding to 2°, 3°, &c. are given in the adjoined table, by examining which it will appear that the distance BD corresponding to any angle ADB (less than 30°) may be obtained nearly by dividing 1719 by the angle ADB in degrees. Thus for 4 degrees the distance by this rule would be $\frac{1719}{4}=429\frac{3}{4}$, nearly, as in the table. The greatest difference between the distances determined by the rule and by the table being 5 feet, corresponding to the angle 30°, for $\frac{1719}{30}=57$; whereas, by the table the distance is 52. In taking soundings by this method it will be very rarely necessary to measure an angle so great as 30°, so that for all practical purposes the distance may be de-

ADB	BD
	feet.
1°	1719
2	859
3	572
4	429
5	343
10	170
20	82
30	52

* A mark may be made at B, and a vane placed at the top of the mast at A, to enable the observer to distinguish those objects when at a great distance. If the height of the observer above the horizon be small in comparison to the height of the mast, the angular distance ADE between the surface of the sea and the top of the boat's mast might be measured, instead of ADB; for if the distances BC and CE remained the same in all observations, it would be immaterial which angle was

termined in this example to a sufficient degree of accuracy by dividing 1719 by the observed angular elevation in degrees. On these principles we have the following rule for calculating the distance corresponding to a mast of any given height, and to any observed angular elevation.

RULE. *Multiply the height of the mast above the eye of the observer by 57.3, and the product will be a constant quantity* which being divided by the observed angle of elevation expressed in degrees and decimals of a degree, the quotient will be the sought distance nearly.*

If the height of the mast be expressed in equal parts taken from the scale by which the chart was plotted off, the distances found by the above rule would be expressed in the same equal parts; so that if the distances thus expressed corresponding to 1°, 2°, 3°, &c. were calculated and marked on a slip of paper (fig. 2, Plate XI.) from H to 1°, from H to 2°, from H to 3°, &c. respectively, the slip H I thus marked, would be a very convenient scale for plotting off such distances.

For further illustration of this method, we have given an example in fig. 4, Plate XI. in which C represents the place at which the sail-boat was at anchor, A and B the points observed, in order to ascertain her position on the chart, by drawing thereon the lines AC, BC, in opposite directions to the bearings of the points A, B, observed from the boat; for the point of intersection C will evidently be the place of the boat upon the chart. Suppose now that in the first set of observations the mast of the sail-boat was made to range on the point A, in this case the course of the boat must be on the continuation of the line AC towards D, then the slip H I (fig. 2, Plate XI.) is to be laid upon the line CD (fig. 4, Plate XI.) with the point H upon C, and the angular elevation being found on the slip the sounding corresponding (reduced to low water) is to be marked on the line CD, immediately under the mark on the slip. Thus if the angle was 4°, the point corresponding would be G. Having plotted off the soundings taken in the direction CD, proceed in the same manner with the others, viz. those in the direction CE found by keeping the boat's mast in a range with the church at H, those in the direction CF found by keeping the boat's mast in a range with the point B, those in the direction CA found by keeping the mast to bear E. N. E. and so on with the other observations; and when all the soundings are marked on the chart, dotted lines are to be made round the shoal soundings, and thus the true figure of the shoal part of the bank will be obtained.

This method I have frequently used in taking a survey of the part of the coast of Massachusetts' Bay, included between Manchester and Lynn. The height of the mast of the boat used on the occasion was about 30 feet, and it was found that distances less than a third of a mile could be obtained in this manner to a great degree of precision.

Second Method. This method of determining the place where soundings were taken consists in keeping (while sailing in a boat and sounding) a particular point of land, or any other object, to bear always in the same direction, and measuring with a quadrant or sextant held in a horizontal position the angular distance between that object and another object (making a considerable angle with the former) for by this means the situation of the boat at the time of sounding may be determined. Instead of bringing the object to bear upon a particular point of the compass, you may (when it can be

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measured; observing however that different scales must be used for plotting off the angles ADB and ADE.

If AB represented the known vertical height of the summit of an island above the eye of an observer, the distance from the island might be determined by measuring the angular elevation ADB, as is evident from what has been said above.

* This constant quantity may be determined without actually measuring the altitude AB, if the angular elevation can be measured at a place D where the distance BD is known. Thus is the example (Plate XI. fig. 4) the distance AC being known, and the angular elevation of the mast at C being observed at A in degrees and decimals of a degree, and multiplied by the distance AC, the product will be the constant quantity mentioned in the rule. This method may be used in determining the distance from an island by the method mentioned in the last note.

done) bring the object in a range with another remarkable object, and by this means you will avoid the error which might arise from the use of a compass.

For an example of this method, suppose that a survey of the small islands A, B, K, (Plate XI. fig. 3) and the large one CHG had been taken and plotted off as in the figure. Then soundings may be taken in the direction BCD by bringing the small island B in a range with the southern part of the great island, and measuring the angle CDG formed by the extremes of the great island; or by keeping the small island A to range with the northern part of the great island, and measuring the angle HIK formed by the northern extreme of that island, and the small island K; or by running in the direction KL so as to keep the island K to bear W. ¼ S. and measuring the angle formed by that island and the northern extreme of the great island, &c.

The method I have generally used for plotting off such angles is by means of a sector; and as that instrument is more easily procured than others better adapted to the purpose, I shall explain the method by showing how the angle CDG, measured as above, may be plotted off so as to determine the point D where that angular distance was observed. To do this, you must draw the line DC, and open the sector till the two legs form with each other an angle equal to the observed angle CDG, then slide one leg of the sector on the line DC till the other leg touches the northern extreme of the island at the point G, and the point directly under the centre of the joint of the sector will be the point of observation: as this point cannot be exactly marked on account of the size of the joint of the instrument, you may mark with a pencil on the line DC the top points where the circumference of the joint touches that line, and note the sounding in the middle between those two marks.

If a quadrant of a circle be described on a piece of paper, with a radius equal in length to one of the legs of the sector, and then divided into 90°, the sector may, by means of that quadrant, be opened to any angle in a very expeditious manner.

This method of obtaining distances when sounding, I have frequently used with success.

To reduce soundings taken at any time of the tide to low water.

The soundings at low water are always to be marked on a chart, and if they are taken at any other time of the tide, a proper allowance must be made to reduce them to low water. This allowance may be made if the whole vertical rise of the tide from low to high water be known, and the time of high and low water, as in the following example.

Suppose the vertical rise of tide from low to high water, to be 10 feet, the time of low water 5h. A. M. and the time of high water 11h. 30m. A. M.; required the allowance to be made on an observation taken at 8 A. M.?

Draw the line AC (Plate XI. fig. 5) and make it equal to the whole rise of the tide 10 feet, taken from any scale of equal parts, and divide the line into equal parts representing feet, at the points 1, 2, 3, &c. to 10, the mark 10 (corresponding to the whole rise of the tide) being at the point C, and through these points draw lines 11, 22, 33, &c. perpendicular to AC, to meet the circumference of a circle drawn on the diameter AC. Divide the semi-circumference ABC of that circle into a number of equal parts representing the number of hours elapsed from low to high water,* which in this case is 6½h. the hour of low water being marked at A, and that of high water at C, the intermediate hours being marked in succession as in the figure;

* This division of the semi-circle may be made by means of a line of chords. The number of degrees corresponding to one hour being found by saying, as the whole elapsed time from low to high water (6½ hours) is to 180° so is one hour to the arch corresponding to 1 hour 27° 42′, which being taken from a line of chords and laid off from 5h. will reach to 6h. &c.

then any hour being found on the arch, the number of the line drawn perpendicular to AC, and passing through the hour, will represent nearly the number of feet to be subtracted from a sounding taken at that time to reduce that sounding to low water. Thus the number of feet corresponding to 8h. is between 4 and 5, because the mark 8h. falls between the lines marked 4 and 5, so that the reduction is between 4 and 5 feet, on soundings taken at 8 A. M. to reduce them to low water on the day of observation; and if on that day the tide does not ebb so much as on a spring tide, the reduction must be increased by the difference in the ebbing of the two tides. Thus if on the day of observation the tide did not ebb so much by two feet as on a spring tide, the reduction corresponding to 8h. ought to be increased two feet, and would therefore be between 6 and 7 feet. Allowance may be made for this by increasing the number of feet marked in fig. 5, by marking 2 feet at A, 3 feet at 1, 4 feet at 2, &c. as is evident.

To reduce a Draught to a smaller Scale.

With a black-lead pencil draw on the draught to be reduced, cross lines, forming exact squares, and on the clean paper for the copy draw the same number of squares, making their sides larger or smaller in proportion to the intended size of the scale, such as ½, ⅓, &c. the length of the other; distinguish by a stronger mark every fifth or sixth row of squares in both, so that the several corresponding squares may be readily perceived; then, in each of the squares of the draught, draw, by the eye, a curve on the paper, similar to that in the square of the copying draught, till the whole is copied; when the black-lead lines may be rubbed out with bread or india ruber.

A chart may also be reduced in the following manner: thus, suppose you would reduce a chart in the ratio of the line MN (Plate XI. fig. 6) to HI. Draw the line AC, which make equal to HI, upon A as a centre, describe the arch CF, and make the chord CF=MN, join AF; then if you take any distance, AB you wish to reduce, and upon A, as a centre, describe an arch BD; the chord BD, intercepted by the lines AC, AF, will be the reduced distance corresponding to AB. This reduced distance may also be obtained by another method, which is more simple than the former: Take any extent from the large chart, which is to be reduced to a smaller scale, and apply it from A to O (Plate XI. fig. 7): take in your compasses the corresponding distance on the small chart, and with one foot in O sweep an arch P; draw the line AP just touching the arch in P; then if you take any distance from the great chart, and apply it from A to R, and at the point R sweep an arch S to touch the line AP; the extent RS will be the reduced distance corresponding to the line AR.

OF WINDS.

THE earth is surrounded by a fine invisible fluid, called Air, which by its weight is capable of supporting the vapours raised by the sun, and by its elasticity is capable of expanding or spreading itself, so as to fill up a larger space. When the elasticity of any portion of the air is changed, by the heat of the sun or by other causes, the neighbouring parts are put in motion to restore the equilibrium; in this manner a current of air is formed, called the *Wind*, which is distinguished by several names, viz. trade winds, monsoons, variable winds, &c. The *trade winds* blow constantly from the same part; the *monsoons* blow half the year one way, and half the other; and the *variable winds* are such as blow without any regularity either as to time, place, or direction. The following observations on the wind have been made by Dr. Halley and others.

There are constant trade winds, blowing from the east, in most parts of the Atlantic and Pacific Oceans, between the latitudes of 30° N. and 30° S.

Near the northern limits of these winds, they blow between the north and east; and near their southern limits, between the south and east.

In the Atlantic Ocean, at about 100 leagues from the coast of Africa, between the latitudes of 28° and 10° north, there is generally a fresh gale of wind blowing from the N. E.

Those bound to the Caribbee Islands across the Atlantic, find, as they approach the American side, that the N. E. wind becomes easterly, or seldom blows more than a point from the east, either to the northward or southward.

These trade winds on the American side are sometimes extended to 30°, 31°, or even to 32° of north latitude, which is about 4° farther than what they extend to on the African side; also to the southward of the equator, the trade winds extend 3 or 4 degrees farther towards the south on the coast of Brazil on the American side, than they do towards the Cape of Good Hope, on the African side.

But we must not conclude that the above limits are without exception; for both their extent and direction vary considerably with the season of the year. When the sun approaches the tropic of cancer the S. E. trade winds prevail farther to the northward of the line, and incline more to the southward of S. E. and the N. E. trade wind inclines more to the eastward; and the contrary at the opposite season of the year.

On the African coast, from Cape Blanco to Sierra Leone, the winds in general blow from the north, inclining from the westward rather than from the eastward. From Sierra Leone to Cape Palmas, the ordinary course of the winds is from W. N. W. and beyond Cape Palmas, as far as 28° south latitude, from S. W. to S. inclining more to the southward or westward according to the particular situation or bearing of the shores and lands. And the part of the ocean extending along this coast to the distance of 80 or 100 leagues from the shore, is much more troubled with frequent calms, and with sudden and violent gusts of wind, known by the name of Tornadoes, which blow from all parts of the horizon. The reason of this change in the direction of the trade wind near the land is probably owing to the nature of the coast, which being violently heated by the sun, rarefies the air exceedingly, consequently the cool air from the sea will keep rushing in to restore the equilibrium.

In the Gulf of Guinea there is a periodical wind, called *Harmattan*, which blows in a N. E. direction from the interior parts of Africa. The season in which this wind prevails is during the months of December, January, and February.

Between the 4th and 10th degrees of north latitude, and between the longitude of Cape Verd and the easternmost of the Cape Verd Islands, there is a tract of sea, which seems to be condemned to perpetual calms, attended with terrible thunder and lightning, and frequent rains. The cause of this seems to be, that the westerly winds, setting in on the coast of Africa, and meeting the general easterly winds in this tract, balance each other, and so cause the calms; and the vapours, carried thither by each wind, meeting and condensing, occasion the almost constant rains.

These observations show the reason of the difficulty which ships find in sailing to the southward, between the coasts of Guinea and Brazil, particularly in the months of July and August, notwithstanding the width of the sea is more than 500 leagues. For the S. E. winds at that time of the year commonly extend some degrees beyond the ordinary limits of 4° north latitude, besides coming so much southerly as to be sometimes south, sometimes a point or two to the west; it then only remains to ply to windward: and if on the one side they steer W. S. W. they get a wind more and more easterly, but then there is danger of falling in with the coast or shoals of Brazil: and if they steer E. S. E. they fall into the neighbourhood of the coast of Guinea, from whence they cannot depart without running easterly as far as the island of St. Thomas.

All ships departing from Guinea for Europe, their direct course is northward; but on this course they cannot go, because the coast, tending nearly

east and west, the land is to the northward; therefore as the winds on this coast are generally between the south and W. S. W. they are obliged to steer S. S. E. or south, and with these courses they run off the shore; but in so doing they always find the wind more and more contrary; so that, though when near the shore they can lie south; at a great distance they can make no better than S. E. and afterwards E. S. E. with which courses they generally fetch the island of St. Thomas or Cape Lopez, where finding the winds to the eastward of the south, they sail westerly with it, till coming to the latitude of 4 degrees south, they find the S. E. wind blowing perpetually.

On account of these general winds, all bound from Europe to the West Indies, or to the southern states of America, consider it most advantageous to get as soon as they can to the southward, so they may be certain of a fair and fresh gale, to run before it to the westward. For the same reason, those bound from America to Europe endeavour to gain the latitude of 30 degrees, where they first find the wind begin to be variable, though the most ordinary winds in the North Atlantic Ocean come between the south and west.

And for the same reasons those bound to India from America run to the eastward in the variable winds. so as to be in the longitude of 35° or 38° W. when in the latitude of 30° N. From thence they steer south-easterly towards the Cape de Verds, passing 4° or 5° to the westward of them, unless they wish to stop for supplies, or to correct their longitude. Being then in the common route of the European Indiamen, they steer south-easterly to cross the equator between the longitude of 18° W. and 25° W. where meeting the S. E. trade winds, they must brace up and sail upon a wind till they get through them, and come into the variable winds, where they may steer to the eastward. Near the equator, the trade wind is generally stronger to the westward than to the eastward; and were it not for the fear of falling in with the Brazil coast, a ship might cross the line farther to the westward than what we have recommended above. Ships homeward bound, from the Cape of Good Hope towards America, may deviate a little to the westward of their straight course, and cross the equator in about 30° W. longitude, in order to take advantage of this fresher trade wind.

Between the southern latitudes of 10° and 30° in the Indian Ocean, the general trade wind about S. E. is found to blow all the year round, in the same manner as in the like latitudes in the south Atlantic Ocean; and during the six months, from May to November, these winds reach to within 2 degrees of the equator; but during the other six months, from November to May, a N. W. wind, called *the little monsoon*, blows in the tract lying between the 3d and 10th degrees of south latitude, in the meridian of the north end of Madagascar, and between the 2d and 12th degrees of south latitude, near the longitude of Sumatra and Java.

In the tract between Sumatra and the African coast, and from 3° of south latitude, quite northward to the Asiatic coast, including the Arabian Sea and the Bay of Bengal, the monsoons blow from October to April on the N. E. and from April to October on the S. W. In the former half year, the wind is more steady and gentle, and the weather clearer than in the latter six months. In the Red Sea the winds blow nearly nine months of the year from the southward, that is, from August to May, and the rest of the year from the N. and N. N. W. with land and sea breezes. In the Gulf of Persia the N. W. wind blows from October to July, and about three months from the opposite quarter. These winds being often interrupted by gales from the S. W. and by land breezes.

Between the island of Madagascar and the coast of Africa, and thence northward as far as the equator, there is a tract, wherein, from April to October, there is generally a S. S W. wind, and a contrary wind the rest of the year, with regular land and sea breezes on both coasts.

To the eastward of Sumatra and Malacca, on the north of the equator,

and along the coasts of Cambodia and China, quite through the Phillippines as far as Japan, the monsoons blow N. E. and S. W. the N. E. setting in about October or November, and the S. W. about May.

Between Sumatra and Java to the west, and New-Guinea to the east, there are regular monsoons. The N. W. monsoon blows from October to April, the S. E. monsoon the rest of the year.

The monsoons do not shift suddenly from one point of the compass to the opposite; in some places, the time of the change is attended with calms, in others by variable winds; and it often happens, on the shore of Coromandel and China, towards the end of the monsoons, that there are most violent storms, called Tuffons, greatly resembling the huricanes in the West Indies, wherein the wind is so vastly strong, that hardly any thing can resist its force; for this reason it is more dangerous to approach those shores at the time of the breaking up of the monsoon than at any other season of the year.

The *land* and *sea breezes* prevail principally between the tropics. The sea breeze generally sets in about ten in the forenoon, and contiues till about five or six in the evening: at seven the land breeze begins, and continues till about eight in the morning. The cause of these winds is this:—during the day the sea is not so much heated by the sun as the land, nor so much cooled at night. Hence, in the day time, the cooler air from the sea will rush towards the land to supply the deficiency occasioned by the greater rarefaction of the air, and hence arises the sea breeze. In like manner, during the night, the air at land, being more cooled than that at sea, will therefore blow from the land towards the sea, and hence occasion a land breeze.

A *whirlwind* is a dangerous phenomenon caused by the adjacent air, rushing in from all parts towards a centre with great rapidity, and destroying every thing it passes over in its progressive motion. A *water spout* and whirlwind arises from the same cause, the latter being formed at land, is composed principally of air, but the former being formed at sea, is composed of water.

It was first observed by Doctor Franklin that the N. E. storms on the coast of the United States of America, frequently begin earlier in the southern states than in the northern. This he accounts for by supposing a great rarefaction of air in or near the gulph of Mexico; the air rising thence has its place supplied by the next more northern, and therefore denser and heavier air; a successive current is thus formed, to which the coast and inland mountains give a N. E. direction.

Experiments have been made by several persons to determine the velocity of the wind, by observing the space passed over by a cloud or any light substance, and by other methods; and it has been found that the velocity of the wind in a violent gale is about 50 or 60 miles per hour.

TIDES.

TIDE is a periodical motion of the water of the sea, by which it ebbs and flows twice a day. The *flow* continues about 6 hours, during which the water gradually rises till it arrives to its greatest height; then it begins to *ebb* or decrease, and continues to do so for about 6 more, till it has fallen to nearly its former level; then the flow begins as before. When the water has attained its greatest height it is said to be *high-water*, and when it is done falling it is called *low-water*.

The cause of the tides is the unequal attraction of the sun and moon upon different parts of the earth. For they attract the parts of the earth's surface nearest to them, with a greater force than they do its centre: and attract the centre more than they do the opposite surface. To restore this equilibrium the waters take a spheroidal figure, whose longer axes is directed

towards the attracting luminary. If the moon only acted upon the water, the time of high water would be when the moon was upon the meridian, above or below the horizon; or rather at an hour or two after, (because the moon continues to act with considerable force for some time after passing the meridian.) But the moon passes the meridian about 49′ later every day; of course, if she only acted on the tides, they would be retarded every day 49′, and it would be high water at the same distance from her passing the meridian; and it is upon this principle that the time of high water is calculated in most books of navigation, although the time thus calculated will sometimes differ an hour from the truth, owing to the neglect of the disturbing force of the sun. The effect of the moon upon the tides is greater than that of the sun, notwithstanding the quantity of matter in the latter is vastly greater than in the former: but the sun, being at a much greater distance from the earth than the moon, attracts the different parts of the earth with nearly the same force; whereas the moon, being at a much less distance, attracts the different parts of the earth with very different forces. According to the latest observations, the mean force of the sun for raising the tides is to the mean force of the moon as 1 to 2¼. By the combined effect of these two forces, the tides come on *sooner* when the moon is in her *first* and *third* quarters, and later in the *second* and *fourth* quarters, than they would do if caused only by the moon's attraction. The mean quantity of this acceleration and retardation is given in Table B, subjoined; the use of which will be explained hereafter.

The tides are greater than common about three days after the new and full moon; these are called *spring-tides*. And the tides are lower than common about three days after the first and last quarters; these are called the *neap-tides*. In the former case the sun and moon conspire to raise the tide in the same place, but in the latter the sun raises the water where the moon depresses it. When the moon is in her *perigee*, or nearest approach to the earth, the tides rise higher than they do, under the same circumstances, at other times; and are lowest when she is in her *apogee*, or farthest distance from the earth. The spring-tides are greatest about the time of the equinoxes, in March and September, and the neap-tides are less. All these things would obtain exactly, were the whole surface of the earth covered with sea; but the interruptions caused by the continents, islands, shoals, &c. entirely alter the state of the tides in many cases. A small inland sea, such as the Mediterranean or Baltic, is little subject to tides; because the action of the sun and moon is always nearly equal at the extremities of such seas. In very high latitudes the tides are inconsiderable.

From the observations of many persons, the times of high-water on the days of new and full moon, in the most noted places of the globe, have been collected. These times are usually put in a table against the names of the places, arranged in alphabetical order as in Table XLVII. of the collection accompanying this work, by means of which the times of high-water may be found by various methods. The most common rule prescribed for this purpose, in books of navigation, is that depending on the golden number and epact, the tide being supposed to be uniformly retarded every day. This method will sometimes differ 2 hours from the truth, for which reason I shall not insert it: but shall proceed to explain the calculation by the adjoined tables A and B, and the Nautical Almanac; by means of which the time of high-water may be obtained to a greater degree of exactness than from our common Almanacs.

RULE.

Find the time of the moon's coming to the meridian at Greenwich on the given day, in page VI. of the Nautical Almanac. Enter Table A, and find the longitude of the given place, in the left hand column, corresponding

to which is a number of minutes to be applied to the time of passing the meridian at Greenwich, by *adding* when in *west* longitude, but *subtracting* when in *east* longitude; the sum or difference will be nearly the time that the moon passes the meridian of the given place. With this time enter Table B, and take out the corresponding correction, which is to be applied to the time of passing the meridian of the place of observation, by adding or subtracting, according to the direction of the table.

To this corrected time add the time of full sea on the full and change days; the sum will be the time of high-water at the given place, reckoning from the noon of the given day. If this sum be greater than 12h. 24m. you must subtract 12h. 24m. from it, and the remainder will be the time of high-water nearly, reckoning from the same noon; or if it exceed 24h. 48m. you must subtract 24h. 48m. from that sum, and the remainder will be the time of high water, reckoning from the same noon nearly.

EXAMPLE I.

Required the time of high water at Charleston, (S. C.) March 17, 1820, in the afternoon, civil account?

By the Nautical Almanac I find that the moon passes the meridian of Greenwich at 2h. 31m.; to this I add 11m. taken from Table A, corresponding to the longitude of Charleston. With the sum 2h. 42m. I enter Table B, and find (by taking proportional parts) that the correction is 45m. which is to be subtracted from 2h. 42m. (because immediately over it in the table it is marked Sub.); to the remainder 1h. 57m. I add the time of high water on the full and change days 7h. 15m. (which is found in the tide table following;) the sum 9h. 12m. is the time of high water on the afternoon of March 17, 1820, civil account.

EXAMPLE II.

Required the time of high water at Portland, (Maine) May 23, 1820, in the afternoon, civil account?

By the Nautical Almanac the moon will pass the meridian of Greenwich at 8 hours 49 minutes. The correction from Table A, corresponding to 70° the longitude of Portland is 9m. which added to 8h. 49m. gives the time of the moon's southing at Portland 8h. 58m. nearly. The number in Table B corresponding to 8h. 58m. is 23m. which is to be added to 8h. 58m. (because immediately over it, in the table, is marked Add.) To the sum 9h. 21m. I add the time of high water, on the full and change days, 10h. 45m. and the sum is 20h. 6m. consequently the high water is at 20h. 6m. past noon of May 23, that is, at 8h. 6m. A. M. of May 24. And by subtracting 12h. 24m. from 20h. 6m. we have 7h. 42m. which will be nearly the time of high water on the afternoon of May 23, 1820.

In this manner we may obtain the time of high water at any place, to a considerable degree of accuracy. But the tides are so much influenced by the winds, freshets, &c. that the calculated times will sometimes differ a little from the truth.

Many pilots reckon the time of high water by the point of the compass the moon is upon at that time, allowing 45 minutes for each point. Thus on the full and change days, if it is high water at noon, they say a north and south moon makes full sea; and if at 11h. 15m. they say a S. by E. or N. by W. moon makes full sea; and in like manner for any other time. But it is a very inaccurate way of finding the time of full sea by the bearing of the moon, except in places where it is high water about noon on the full and change days.

When you have not a Nautical Almanac, you may find the time of high water by means of the following tables C and D; and although the former method is the most accurate, yet the latter may be useful in many cases. To calculate the time of full sea by this method, observe the following rule.

RULE.

Enter Table C, and take out the number which stands opposite to the year, and under the month for which the tide is to be calculated; this number, added to the day of the month, will give the moon's age, rejecting 30 when the sum exceeds that number. Against her age found in the left hand column of Table D, is a number of hours and minutes in the adjoined column, which being added to the time of high water at the given place on the full and change days, will give the time of high water required, observing to reject 12h. 24m. or 24h. 48m. when the sum exceeds either of those times.

By this rule I shall work the two preceding examples.

EXAMPLE III.

Required the time of high water at Charleston, (S. C.) March 17, 1820, in the afternoon, civil account?

In the table C, opposite 1820, and under March, stand 16, which, added to the day of the month 17, gives 33, and by subtracting 30, leaves 3, the moon's age: opposite 3 in Table D, is 1h. 46m. which added to 7h. 15m. the time of high water on the full and change days, gives 9h. 1m. for the time of high water; differing eleven minutes from the former method.

EXAMPLE IV.

Required the time of high water at Portland, (Mass.) May 23, 1820, in the afternoon, civil account?

In the Table C, opposite 1820, and under May, stand 18, which added to the day of the month 23, gives (by neglecting 30) the moon's age 11; opposite to this, in Table D, is 9h. 19m. which added to 10h. 45m. the time of high water on the full and change days, gives 20h. 4m. from which subtracting 12h. 24m. there remains 7h. 40m. for the time of full sea May 23, 1820; this differs 2 minutes from the former method.

In the third column of Table D is given the time of the moon's coming to the meridian, for every day of her age: thus, opposite 11 days stand 8h. 57m. which is the time of her coming to the meridian on that day. This table may be of some use when a Nautical Almanac cannot be procured; but being calculated upon the supposition that the moon moves uniformly in the equator, the table cannot be very accurate. The numbers in this Table are reckoned from noon to noon; thus, 1h. A. M. is denoted by 13h.; 2h. A. M. by 14h. &c.

The time of new moon is easily found, by subtracting the number taken from Table C from 30. Ex. Suppose it was required to find the time of new moon for May, 1820? By examining the table, we find the number corresponding to that time is 18; this subtracted from 30 leaves 12; therefore it will be new moon the 12th May, 1820.

When the time of high water is known for any day of the moon's age, we may from thence find the time of high water on the full and change days, by the following

RULE.

Find the time of the moon's coming to the meridian of Greenwich, in page VI. of the Nautical Almanac; to this time apply the corrections taken from the tables A and B, (in the same manner as directed in the preceding rule for finding the time of high water) subtract this corrected time from the observed time of high water, and the remainder will be the time of high water, on the change and full days.

NOTE. If the time to be subtracted be greater than the observed time of full sea, you must increase the latter by 12h. 24m. or by 24h. 48m. nearly.

EXAMPLE.

Suppose that on the 17th March, 1820, the time of high water at Charles-

ton, (S. C.) was found to be at 9h. 12m. P. M. required the time of high water on the full and change days?

I find, as in example 1st. preceding, that the number to be subtracted is 1h. 57m.—taking this from 9h. 12m. leaves 7h. 15m. which is the time of high water on the full and change days.

When you have not a Nautical Almanac, you may find the time of high water on the full and change by means of the Tables C and D. For in the present example, I find by Table C, that the moon's age was 3, corresponding to which, in the second column of Table D, is 1h. 46m. this subtracted from 9h. 7m. leaves 7h. 21m. for the time of high water on the full and change days.

Tab. A.

Longitude of the place. Deg.	Cor. of Moon's passing the meridian. M. m
0	0
10	1
20	3
30	4
40	5
50	7
60	8
70	9
80	11
90	12
100	14
110	15
120	16
130	18
140	19
150	20
160	22
170	23
180	24

Tab. B.

Time of Moon's passing the meridian. Hours	Corr. H.	M.
	Sub.	
0	0	0
1	0	17
2	0	34
3	0	50
4	1	3
5	1	9
6	1	3
7	0	35
	Add	
8	0	2
9	0	23
10	0	24
11	0	14
12	0	0
	Sub.	
13	0	17
14	0	34
15	0	50
16	1	3
17	1	9
18	1	3
19	0	35
	Add	
20	0	2
21	0	23
22	0	24
23	0	14
24	0	0

Tab. C.

A TABLE

FOR FINDING THE MOON'S AGE.

Add the number taken from this Table to the day of the month; the sum (rejecting 30 or 60 if necessary) will be the Moon's age nearly.

Year	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1820	15	17	16	18	18	20	20	22	23	23	25	25
1821	26	28	26	28	29	1	2	3	4	5	6	6
1822	7	9	7	9	10	11	12	14	15	16	17	17
1823	18	20	18	19	20	22	22	24	26	26	28	28
1824	29	1	0	1	2	4	4	6	8	8	10	10
1825	12	13	11	12	13	14	15	16	18	19	19	21
1826	22	24	23	23	24	25	25	27	29	29	1	2
1827	3	5	3	05	5	6	7	8	10	10	12	12
1828	14	15	15	16	17	18	19	19	21	22	23	24
1829	25	26	25	27	28	29	0	1	2	3	4	5
1830	6	8	6	8	9	10	11	12	13	14	15	16
1831	17	18	17	18	19	20	21	23	24	25	26	27
1832	28	29	28	0	1	3	3	5	7	7	8	9

Tab. D.

Moon's Age. Day	High Water. H	M.	Moon passes meridian. H.	M.
0	0	0	0	0
1	0	35	0	49
2	1	10	1	38
3	1	46	2	26
4	2	22	3	15
5	3	1	4	4
6	3	44	4	53
7	4	35	5	42
8	5	39	6	30
9	6	57	7	19
10	8	15	8	8
11	9	19	8	57
12	10	10	9	46
13	10	54	10	34
14	11	33	11	23
15	12	9	12	12
16	12	44	13	1
17	13	19	13	50
18	13	54	14	38
19	14	31	15	27
20	15	11	16	16
21	15	56	17	5
22	16	49	17	54
23	17	57	18	42
24	19	17	19	31
25	20	32	20	20
26	21	38	21	9
27	22	22	21	58
28	23	4	22	46
29	23	42	23	35
29½	24	0	24	0

In all the preceding calculations of the time of high water, we have neglected the correction arising from the variation of the distances of the sun and moon from the earth, and from the different declinations of those objects. These causes might produce a correction of 10′ or 12′ in the time of high water, but in general will be much less, and may therefore be neglected.

CURRENTS.

A CURRENT is a progressive motion of the water, causing all floating bodies to move that way towards which the stream is directed. The *set of a current*, is that point of the compass towards which the waters run, and its *drift* is the rate it runs per hour. The most usual way of discovering the set and drift of an unknown current, is thus:

Let three or four men take a boat a little way from the ship: and by a rope fastened to the boat's stern, let down a heavy iron pot or loaded kettle to the depth of 80 or 100 fathoms; then heave the log, and the number of knots run out in half a minute will be the miles the current sets per hour, and the bearing of the log will show the set of it.

There is a very remarkable current, called the GULF STREAM, which sets in a north-east direction along the coast of America, from Cape Florida towards the Isle of Sables, at unequal distances from the land, being about 75 miles from the shore of the southern states, but more distant from the shore of the northern states; the width of the stream is about 40 or 50 miles, widening towards the north; the velocity is various from one to three knots per hour, or more, being greatest in the channel between Florida and the Bahamas, and gradually decreasing in passing to the northward; but is greatly influenced by the winds both in drift and set.

We are chiefly indebted to Doctor Franklin, Commodore Truxton, and Mr. Jonathan Williams, for the knowledge we possess of the direction and velocity of this stream; its general course, as given by them, is marked on the chart affixed to this work. They all concur in recommending the use of the thermometer, as the best means of discovering when in, or near the stream. For, it appears by their observations, that the water is warmer than the air when in the stream; and that at leaving it, and approaching towards the land, the water will be found six or eight degrees colder than in the stream, and six or eight degrees colder still, when on soundings. Vessels coming from Europe to America, by the northern passage, should keep a little to the northward of the stream, where they may probably be assisted by a counter current, as is observed by Commodore Truxton. When bound from America to Europe, a ship may generally shorten her passage by keeping in the gulf. By steering N. W. you will generally cross the gulf in the shortest time, as the direction of the stream is nearly N. E. Those who wish for further information on this subject, may consult an ingenious treatise on "Thermometrical Navigation," published by Mr. Jonathan Williams, at Philadelphia, in 1799, and re-published by Edm. M. Blunt, to accompany his Chart of the Western Ocean, in 1819.

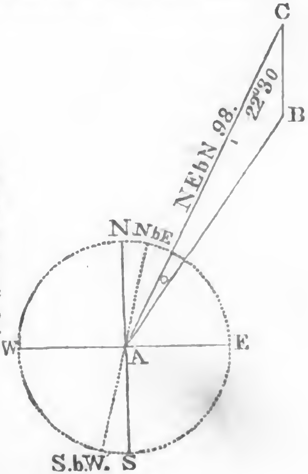
In the other parts of the Atlantic ocean the currents are variable, but are generally south-easterly, along the coast of Spain, Portugal and Africa, from the Bay of Biscay towards Madeira and the Cape de Verds. Between the tropics there is generally a current setting to the westward.

There is also a remarkable current which sets through the Mozambique channel, between the Island of Madagascar and the main continent of Africa, in a south-westerly direction: in proceeding towards Cape Lagullas the current takes a more westerly course, and then tends round the Cape towards St. Helena. Ships bound to the westward from India, may generally shorten their passage, by taking advantage of this current. On the contrary, when bound to the eastward, round the Cape of Good Hope, they ought to keep far to the southward of it. However, there appears to be a great difference in the velocity of this current at different times; for some ships have been off this Cape several days endeavouring to get to the westward, and have found no current; others have experienced it setting constantly to the westward during their passage from the Cape towards St. Helena, Ascension and the West-India Islands.

All cases of sailing in a current are calculated upon the principle, that the ship is affected by it in the same manner as if she had sailed in still water, with an additional course and distance exactly equal its set and drift: on this principle the projection and calculation of any problem of this kind may be easily made.

EXAMPLE.

If a ship sails 98 miles N. E. by N. in a current which sets S. by W. 27 miles in the same time; required her true course and distance?



BY PROJECTION.

Describe the compass NESW, through the centre A draw the N. E. by N. line AC=98 miles, through C draw the line CB parallel to the S. by W. line, and make CB=27 miles, and join AB. Then AB will be the course and distance made good, which by measuring are N. E. ¼ N. 74 miles.

BY CALCULATION.

The shortest method of calculating this problem is by means of Table I. as in the adjoined Traverse Table; putting in it the course sailed by the ship, and the set of the current, and finding the difference of latitude and departure by that Table, then find the course and distance made good, as in Case VI. Plane Sailing. In the present example the course is N. E. ¼ N. and the distance 74 miles nearly.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
N.E.byN.	98	81.5		54.4	
S. by W.	27		26.5		5.3
		81.5	26.5	54.4	5.3
		26.5		5.3	
	Diff. Lat.	55.0	Dep.	49.1	

METHOD OF KEEPING
A SHIP'S RECKONING OR JOURNAL AT SEA.

A SHIP'S RECKONING is that account, by which it can be known at any time where the ship is, and on what course or courses she must steer to gain her port. DEAD RECKONING is that account deduced from the ship's run from the last observation.

THE LOG-BOARD.

H.	K.	F.	Courses.	Winds.	Lee-way	Transactions.
2	6		S. W.	N. E.		
4	5	5				
6	5			N.W.by W.		
8	5					Moderate gales &
10	4	5	E. N. E.	N. W.		fair weather; at
12	4	5				8 A. M. saw a
2	4	5				ship to the north-
4	4	5				ward.
6	4	5				
8	5		S. W.	W. N. W.	1	
10	4	5				No observation.
12	4					

The daily occurrences on board a ship are marked on a board or slate, called the *log-board* or *log-slate*, kept in the steerage for that purpose, being usually divided into seven columns; the first contains the hours from noon to noon, being marked by some for every two hours, but by others for every single hour; in the second and third columns are the knots and fathoms the ship is found to run per hour, set against the hours when the log was hove. Some navigators do not divide the knot into ten fathoms, but into half knots only, marking the third column H. K. The fourth column contains the courses steered by compass; the fifth, the winds; the sixth, the lee-way,* and the seventh, the alteration of the sails, the business done aboard, and what other remarks the officer of the watch thinks proper to insert. For it should be observed, that it is usual to divide a ship's company into two parts, called the starboard and larboard watches, who do the duty of the ship for four hours and four hours, alternately, except from 4 to 8 P. M. which is divided into two watches. The remarks made on the log-board are daily copied into a book called the LOG-BOOK, which is ruled like the log-board. This book contains an authentic record of the ship's transactions, and the persons who keep a reckoning, transcribe them into their *journals*, and from thence make the necessary deductions relative to the ship's place, every day at noon, which operation is called working a *day's work*. While a ship is in port, the remarks entered in the log-book are called *harbour work*, or *harbour journals*, and the day is then estimated according to the civil computation as on shore, that is from mid-night to mid-night; but at sea the day's work ending at noon is dated the same as the civil day, so that the day's work marked Monday began on Sunday noon, and ended on Monday at noon; the day thus marked is called a *nautical day*; the first 12 hours being marked P. M. the latter A. M. There are various ways of keeping journals at sea, according to the different tastes of navigators. Some keep only an abstract of each day's transactions, specifying the weather, what ships or lands were seen, accidents on board, the latitude, longitude, course, and run: these particulars being drawn from the ship's log-book. Others keep a full copy of the log-book, and the deductions drawn therefrom, arranged in proper columns:—this is the most satisfactory method to those who may have occasion to inspect the journal; and we have adopted it in the following, but shall give an abstract at the end conformable to the other method.

When a ship is about losing sight of the land, the bearing of some noted place (whose latitude and longitude are known) must be observed, and its distance estimated and marked on the log-book: this is called *taking a departure*. In working this first day's work, the calculation is to be made in the same manner as if the ship had sailed that distance from that place upon a course opposite to that bearing, and that course and distance are to be entered accordingly into the traverse table, after allowing for the variation.

To allow for the Variation.

We have already taught the methods of finding the variation, which must be allowed on all courses steered, and on all bearings taken with the compass; *to the right hand. if the variation be east; but to the left hand, if west;* the observer being supposed to be placed in the centre of the compass, looking towards the point from which the variation is to be allowed.

* The cause of the lee-way and manner of allowing for it, are explained in the following pages.

EXAMPLES.

		Points.	
Course by compass	N. E. by E.	Variation 2 W.	True course N. E. by N.
	N. E.	1¾ E.	N. E. by E. ¾ E.
	N. W.	3 W.	W. by N.
	S. E.	3 E.	S. by E.
	S. S. W.	1½ W.	S. ½ W.
	E. S. E.	1½ W.	E. ½ S.
	S. W. ¼ W.	¾ W.	S. W. ½ S.
	N. N. E. ¾ E.	1¾ E.	N. E. ½ E.

To find the lee-way and allow for it.

The courses must likewise be corrected for lee-way, the nature of which may be thus explained. When a ship sails upon a wind, in a fresh gale, that part of the wind which acts upon the hull and rigging, together with a considerable part of the force exerted on the sails, tend to drive her immediately from the direction of the wind, or, as it is termed, to leeward. But since the bow of a ship exposes less surface to the water than the side, the resistance will be less in the first case than in the second; the velocity therefore in the direction of her head will, in most cases, be greater than the velocity in the direction of her side, and the ship's course will be between the two directions, and the angle contained between the course towards which the ship's head is directed, and the course she really describes through the water, is termed her *lee-way*. The quantity of lee-way to be allowed will depend upon a variety of circumstances; as the mould and trim of the ship; the quantity of sail she carries; her velocity through the water, &c. hence no general rules can be laid down with accuracy that will determine the quantity of lee-way in all cases. The following have, however, been usually given by most writers on navigation.

1. When a ship is close hauled with all her sails set, the water smooth, and a light breeze of wind, she is then supposed to make little or no lee-way.
2. When the top-gallant sails are handed, allow 1 point.
3. When under close reefed topsails, allow 2 points.
4. When one topsail is handed, allow 2½ points.
5. When both topsails are handed, allow 3½ points.
6. When the fore course is handed, allow 4 points.
7. When under the mainsail only, allow 5 points.
8. When under a balanced mizen, allow 6 points.
9. When under bare poles, allow 7 points.

As these allowances depend entirely on the quantity of sail set, without regard to any other circumstance, it is evident that they can be considered only as probable conjectures, and may indeed serve to work up the day's work of a journal that has been neglected. But since the computation of a ship's way depends much upon the accuracy of this allowance, it would be proper for the officer of the watch to mark the lee-way on the log-board, in the column reserved for that purpose. The lee-way may be estimated by observing the angle which the wake of the ship makes with the point right astern, by means of a semi-circle marked on the taffrail, and divided into points and quarters; by means of which the angle contained between the direction of the wake and the point of the compass directly astern, may be easily ascertained.

The lee-way thus determined is to be allowed on all courses *steered, to the right hand of the course steered, when the larboard tacks are aboard,** *but on the left hand, when the starboard tacks are aboard*; the person making the allowance being supposed to be looking towards the point of the compass the ship is sailing upon.

EXAMPLES.

Courses steered.	Wind.	Lee-way.	True course.
N. W.	N. N. E.	1 point.	N. W. by W.
E. N. E.	North.	2	East.
E. S. E.	South.	1	E. by S.
W. by N.	N. by W.	½	W. ½ N.
E. N. E. ½ E.	S. E.	3	N. E. ½ N.

* See the note page 143.

When the variation and lee-way are both to be allowed on a course, you may do it at once, by allowing their sum when they are both the same way, or their difference when the allowance is to be made in different ways, taking care to make the allowance in the same way as the greater quantity ought to be, whether it be the variation or lee-way.

EXAMPLE I.

A ship steers W. by N. with her larboard tacks aboard, and makes one point lee-way, there being two points westerly variation; required the true course?

Lee-way to the right hand	1 point
Variation to the left	2 points
Difference allowed to the left	1 point

Whence the course is west.

EXAMPLE II.

A ship steers E. S. E. with her starboard tacks aboard, and makes two points lee-way, there being one point westerly variation; required the true course?

Lee-way to the left	2 points
Variation to the left	1 point
Sum allowed to the left	3 points

Whence the course is E. by N.

In a violent gale, with a head wind and heavy sea, when it would be dangerous to carry sail, it is usual to lie to under sufficient sail to prevent the vessel from rolling so much as to endanger the masts and rigging. When a ship is lying-to, the tiller is put over to leeward, and when the ship has headway, the rudder acts upon her to bring her to the wind; the ship then loses her way in the water, which ceasing to act on the rudder, her head falls off from the wind, and the sail which is set fills and gives her fresh way through the water, which acting on the rudder, brings her head again to the wind. Thus the ship is kept continually falling off and coming to. In this case, you must observe the points on which she comes up and falls off, and take the middle between the two points for the apparent course, from which allow the variation and lee-way, and you will obtain the true course.

EXAMPLE.

A ship lying-to under her mainsail, with her starboard tacks aboard, comes up E. by S. and falls off N. E. by E. there being one point westerly variation, and she makes 5 points lee-way—what course does she make good?

The middle between E. by S. and N. E. by E. is E. by N.; and by allowing 6 points to the left hand (viz. 5 for lee-way and 1 for variation) the true course will be obtained N. by E.

To exercise the learner we shall add the examples of correcting for variation and lee-way contained in the following Table.

THE TABLE.

Courses steered.	Winds.	Lee-way points	Variation points	Courses corrected.
N. W. ¼ W.	N. N. E.	¾	¾ W.	N. 5¾ W.
W.	N. N. W.	1	¾ W.	S. 6¼ W.
W. S. W.	S.	1	¾ W.	S. 6¼ W.
W.	S. S. W.	¾	¾ W.	W.
W. by N.	N. by W.	1¼	¾ W.	S. 7 W.
S. W.	W. N. W.	1½	¾ W.	S. 1¾ W.
S.	W. S. W.	¾	1¼ W.	S. S. E.
S. S. W.	W.	1	1¼ W.	S. ¼ E.
S. W.	N. W. by W.	¼	1¼ W.	S. S. W. ½ W.
W.	S. S. W.	1¾	1¼ W.	W. ½ N.
W. by N.	N. by W.	1	1¼ W.	W. S. W. ¾ W.
S.	E. S. E.	2	1¼ W.	S. ¾ W.
E. by S.	S. ½ E.	¾	1¼ W.	E. by N.
E. N. E.	N.	1¾	1¼ W.	E. N. E. ½ E.
E.	N.	¾	1¼ W.	E. ½ N.
E.	S.	0	1¼ W.	E. N. E. ¾ E.
S.	E. S. E.	¼	1¾ W.	S. by E. ½ E.
E. S. E.	N. E.	½	1¾ W.	E. ¾ S.
W. S. W.	S.	¾	1¾ W.	S. W. by W.
W. by N.	S. W. by S.	1	1¾ W.	W. ¼ N.
N. W.	W. S. W.	1	1¾ W.	N. W. ¾ W.
S.	W. S. W.	1	½ E.	S. ½ E.
N. by E.	N. W. by W.	¾	1 E.	N. N. E. ¾ E.
N. W. by N.	W. by S.	1¼	1 E.	N. ¾ W.
N. W. by W.	N. by E.	1¾	1¼ E.	N. W. by W. ½ W.
W. by S.	N. W. by N.	1¾	2¼ E.	W. ½ S.

If the ship has been acted upon by a current or a heave of the sea, you must allow the set and drift as a course and distance in the Traverse Table, as directed in p. 219.

Having corrected the courses for lee-way and variation, and estimated the distances sailed, the latitude and longitude in at noon are to be found by either of the preceding methods of sailing. The latitude and longitude, thus calculated, are called the latitude and longitude by *dead reckoning*, and if the real course and distance made good by the ship could be estimated accurately by the compass and log, nothing more would be necessary to determine the ship's place at any time; but by

reason of the various accidents that attend a ship's way, such as heave of the sea, unknown currents, different rates of sailing between the times of heaving the log, sudden squalls, improper allowance for lee-way and variation, the latitude and longitude of the ship as deduced from the reckoning, will frequently differ from the latitude and longitude by observation. In this case it will be proper to re-examine the calculation to see whether a just allowance has been made for lee-way, variation, bad steerage, drift of the sea, error of the log-line and glass, &c. since it will sometimes be found that a different and more probable estimate of some of these quantities will make the dead-reckoning agree more nearly with the observations. Before the method of finding the longitude by lunar observations was introduced, the mariner had no other observation to be depended on except his latitude, and it was then usual to make allowances for supposed errors in the courses and distances, so as to make the latitude by observation and dead-reckoning agree. The method made use of by Robertson, Moore, and others, was divided into three cases, viz.

CASE I.

When the course was within three points of the meridian, the error was supposed to be wholly in the distance, on the principle that it would require a greater error in the course to cause the given error in the difference of latitude than could be supposed probable to have been committed. In this case the corrected departure, &c. were found, with the course, by dead-reckoning, and the difference of latitude by observation, as in Case IV. of Middle Latitude or Mercator's Sailing.

CASE II.

When the course was between three and five points of the meridian, the error was supposed to be part on the course and part on the distance. In this case, the *corrected* departure was taken equal to the mean of the departure by dead-reckoning, and the departure which corresponds to the distance by dead-reckoning, and the difference of latitude by observation. With the *corrected* departure, and the difference of latitude by observation, the course, &c. were found as in Case II. of Middle Latitude or Mercator's Sailing.

CASE III.

When the course was more than five points from the meridian, the error was supposed to be wholly on the course, on the principle that it would require a greater variation in the distance to make the dead-reckoning and observation agree, than could be supposed probable, whereas it could require but a small change in the course to produce the sought effect. In this case, the corrected departure, &c. were found, with the distance, by dead reckoning, and the difference of latitude by observation, by Case V. of Middle Latitude or Mercator's Sailing.

This method was given in the former editions of this work, in conformity to custom, though I was decidedly opposed to making such corrections, being convinced that the difference between the dead-reckoning and observation is more owing to unknown currents than to errors in the courses and distances given by the log. Even admitting the principle that an arbitrary correction of this kind is proper, the preceding method does by no means appear to be the most probable. To show this, let us take the following example.

Suppose the course by dead-reckoning to be 33° 44′ 59″, the distance by the log. 100 miles, and the difference of latitude by observation 73.1 miles. This comes under Case I. and the error must be placed wholly on the distance, which is to be found with the course 33° 44′ 59″ (or 3 points nearly) and the difference of latitude 73.1, so that the corrected quantities are nearly by Table I. course 33° 44′ 59″, distance 88, and departure 48.8. Now by altering the course two seconds, making it 33° 45′ 1″, still retaining the distance by dead reckoning 100 miles, and the difference of latitude by observation 73.1, the example will come under Case II. and the corrected depar-

ture is the mean of the departure by dead-reckoning 55.6, and that corresponding to the distance 100, and the difference of latitude by observation 73.1; namely 68.2, so that this *corrected* departure is 61.9 miles, with which and the difference of latitude by observation 73.1, we obtain the corrected course 40° 15′ and the distance 96. Thus we see that by altering the course by dead reckoning *only two seconds*, the corrected course varies from 33° 44′ 59″ to 40° 15′ or above 6 degrees, and the departure varies from 48.8 to 61.9, both of which are highly improbable. This defect of the rule evidently arises from the sudden change of the method when the course is near 3 or 5 points; it being much more probable that the variations take place by small degrees, in such manner that when the course by dead-reckoning is exactly on the meridian, the error ought to be in the distance, and when the course is 8 points from the meridian, the error ought to be in the course, and at intermediate courses the errors in distance ought to be greater, the nearer the course is to the meridian, and the errors in the course greater, the farther it is from the meridian. Both these objects are attained in a very simple manner, in the method proposed by the ingenious methematician, Dr. Adrian, late Professor of Mathematics and Natural Philosophy in Columbia College, New-York, which is somewhat similar to my method of correcting a survey. *His method consists in finding, with the difference of latitude by observation, and the departure by account, the corrected course, distance, and difference of longitude by Case II. of Middle Latitude or Mercator's Sailing*, so that no correction whatever is made in the departure. The propriety of this method will appear evident by observing that a change in the departure can have no tendency whatever in correcting an error in the latitude, and there can be no reason given why such change should be made to the eastward rather than to the westward, since it is supposed that all the allowances for heave of the sea, falling off the course, variation, error of the log, &c. have been previously taken into the calculation, and it seems to be contrary to sound reasoning to vary any of the elements when it will not serve to correct the known error of the latitude, particularly when there can be no reason given why the change should be made in one direction rather than another. In addition to this, the proposed method is not liable to the inconvenience of a sudden change in the rules when the course is near 3 or 5 points. It has also another advantage with respect to simplicity of calculation arising from the circumstance that the corrected difference of longitude is nearly the same as the difference of longitude by dead-reckoning. For the departure is not varied by the rule, and the middle latitude differs rarely more than a few minutes on account of the difference between the latitude by observation and account, so that in keeping a journal it will not be necessary to make any change in the longitude by dead-reckoning, even if you have not had an observation for several days. To illustrate this method I shall give the following

EXAMPLE.

Yesterday at noon we were in the latitude of 39° 18′ N. and by an observation at noon this day are in the latitude of 37° 48′ N. our dead-reckoning gives 107 miles southing and 64 miles westing. Required the course, distance, and difference of longitude?

With the difference of latitude by observation 90 miles (the difference of 37° 48′ and 39° 18′) and the departure by dead-reckoning 64 miles, I find by Case II. of Mid. Lat. Sailing, the course nearly 35°, and the distance 110 miles; and with the middle latitude by observation 38° 33′, and the departure 64 miles, I find the difference of longitude to be 82 miles. If the middle latitude by dead-reckoning 38° 41′ had been taken, the result would have been nearly the same.

If you have not had an observation several days, and then find an error in the latitude by account, you may on these principles correct the latitude

on the intermediate days, by saying, *as the sum of all the distances sailed, since the first observation, is to the whole error in the latitude, so is the sum of the distances sailed from the time of taking the first observation, to the noon of any particular day, to the correction of the latitude by dead-reckoning on that day, southerly if the last latitude by observation is south of the latitude by dead-reckoning, otherwise northerly.* Thus, if the latitudes by dead-reckoning at noon, on four successive days, were 41° 0′, 41° 30′, 42° 0′, 43° 0′, the latitude by observation on the first day 41° 0′, and on the last day 43° 15′; differing 15 miles from the latitude by account; the distances sailed by the log, on the three days respectively, 30, 90, and 105 miles; we must say, as the whole sum of the distances 225 miles, is to the error of the latitude 15 miles, so is the first distance 30, to the correction of the second latitude 2′, and so is the sum of 30 and 90 (=120) to the correction of the third latitude 8′, so that the corrected latitudes will be 41° 0′, 41° 30′ + 2′ = 41° 32′, 42° 0′ + 8′ = 42° 8′ and 43° 15′, and the corrected differences of latitude on the successive days will be 32′, 36′, and 67′, with which and the departure by dead-reckoning, the corrected courses, distances, &c. on each day may be found, if thought necessary; but as the corrected longitude is not sensibly altered by any of these corrections, it appears to be in general wholly unnecessary to make any alteration in the Journal on this account. But if it be thought proper to notice these corrections in plotting off the track of a ship, it will be necessary first to plot off the courses by D. R. and then to place the points arrived at, at the end of each day, as much to the north or south of the places by D. R. as will make the latitudes of those points agree with the corrected latitudes found by the above rule.

The latitude and longitude by dead-reckoning being found by the preceding methods; thence may be determined the bearing and distance of the place of destination; but when the mariner is fearful that his longitude by account is inaccurate, and he has no lunar observations to correct it, he must get into the latitude of the place, and (if possible) run east or west according to his situation, and the prevailing state of the winds.

We have now given all the rules necessary for working a day's work and for the convenience of the learner (to enable him to refer to them easily) we have here collected them in the seven following articles.

Rules for working a day's work.

1. Correct the several courses sailed* for variation and lee-way, and enter them in a traverse-table, and opposite to each course place the distance run on that course, found by summing up the knots and fathoms sailed by the ship on that course. Find in Table I. or II. the difference of latitude and departure corresponding to each course and distance, and set them in their respective columns: then the difference between the sums of the northings and southings will be the difference of latitude made good, of the same name with the greater; and the difference between the sums of the eastings and westings will be the departure made good, of the same name with the greater quantity.

2. Seek in Table I. or II. until the above difference of latitude and departure are found together in their respective columns; opposite to these will be the distance made good, and at the top or bottom of the page, according as the departure is less or greater than the difference of latitude, will be found the course.

3. If the latitude from which the ship's departure is taken, or yesterday's latitude, be of the same name as the difference of latitude, add them together; but if of different names, take their difference; the sum or remainder will be the present latitude, of the same name as the greater.

4. Find the middle latitude between the latitude of yesterday and this

* The set and drift of a current (if there be any) is to be reckoned as a course and distance, and on the first day after losing sight of the land the bearing and distance of it are to be taken into account.

day, which take as a course in Table II. and seek for the departure in the column of Diff. Lat. then will the distance corresponding, be the difference of longitude, of the same name as the departure.

5. If the longitude in yesterday be of the same name as the difference of longitude, add them together; but if of different names, take their difference; the sum or remainder will be the long. in, of the same name as the greater.

6. If a lunar observation were taken at any time of the day, you must find, by the above method, the difference of longitude made since taking the observation for regulating the watch, and thence the longitude in at noon by that observation, and enter it in the Journal as the longitude by observation.

7. Find on a general chart the spot corresponding to the latitude and longitude by observation, and that place will represent the situation of the ship, whence the bearing and distance of the intended port may be found. The same may be obtained by middle latitude sailing, by inspection of Table II. thus: Find the middle latitude between the place of the ship and the proposed place, and seek for that latitude as a course in Table II. and find in the corresponding page of the Table, the difference of longitude (between the ship and the proposed place) in the distance column, opposite to which, in the latitude column, will be the departure. Seek in Table I. for this departure and the difference of latitude (between the ship and the proposed place) till they are found to agree, corresponding thereto will be the bearing and distance required. If the magnetic bearing be required, the variation must be allowed on the true bearing; to the right hand if the variation is westerly, or to the left hand if easterly.

We shall now proceed to exemplify the above rules; first by a few examples of separate day's works, and then by a Journal from Boston to Madeira, kept in the usual form.

EXAMPLE I.

Yesterday, at noon, we were in the latitude of 48° 21′ N. and the longitude of 36° 28′ W. and have sailed till this day at noon, as per log-board; required the course and distance made good, with the latitude and longitude in?

LOG-BOARD.

H	K.	F.	Courses.	Winds.	L W	Remarks.
2	6		S. W. by W. ¾ W.	N.		These 24 hours moderate gales
4	5	5				and cloudy weather.
6	5			N. W.		At 4 P. M. spoke ship Washing-
8	5					ton, from New-York, bound to
10	3	6	S. W. ¾ W.			Cork.
12	3	4				
2	3	4				
4	4	5				
6	4	6				At 6 A. M. stowed the anchors and
8	5		S. W. ¼ S.	W.N.W.		unbent the cables and coiled
10	4	5				them between decks.
12	4					Variation 2¼ points westerly.*

By examining the log-board it appears that the ship goes large and makes no lee-way; therefore by allowing the variation on each of the courses, they will stand as in the adjoined Traverse Table. Then the distances marked on the log-board must be summed up and doubled, because marked only for every two hours.† In allowing for the knots, you must reckon 10 to a mile; and when the tenths are above 5, you must add one mile to the distance. Having found the distances you must find the corresponding differences of latitude and departures, in Table I. or II. and then with the whole difference of latitude and departure, find the course and distance made good, and the difference of longitude, by Case II. of middle latitude sailing.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. W. ½ S.	43		33.2		27.3
SSW. ½ W.	39		34.4		18.4
S by W ½ W	27		25.8		7.8
	Diff.	Lat.	93.4	Dep.	53.5

In the present example, the difference of latitude is 93′ = 1° 33′ S.
Yesterday's latitude . . . . 48 21 N.

The difference is the latitude in . . . . 46 48 N.
Sum of latitudes 95 9
Middle latitude 47 34

With the difference of latitude made good 93.4 S. and the departure 53.5 W. I enter Table II. and find they correspond nearly to a course of S. 30° W. and distance 108 miles. Then with the middle latitude 47° 34′ or 48°, I enter Table II. and find the departure 53.5 in the lat. column, opposite to which, in the distance column, is the diff. of long. 80′ = 1° 20′ W.
Longitude left . . . . 36 28 W.

Sum is the longitude in . . . . 37 48 W.

* As these examples were given only to illustrate the rules, we have not been attentive to mark the true variation.

† In India voyages it is customary to mark the log-board every hour; in that case, the distances marked on the log being summed up, will be the true distance sailed.

EXAMPLE II.

Yesterday at noon we were in the latitude of 35° 46′ N. and the longitude of 17° 42′ W. and have sailed till this noon as per log-board: required the latitude and longitude in, and the bearing and distance of Cape St. Vincent?

LOG-BOARD.

H	K.	F.	Courses.	Winds.	L.W.	Remarks.
1	6	6	S. by E. ½ E.	S. W. ½ W.	1½	These 24 hours moderate gales and clear weather.
2	6	6				
3	5	8				
4	5	8				
5	5	8				
6	5	8				
7	5	8				
8	5	8				
9	5		S. S. E.	S. W.	1½	
10	5					
11	5	2				At 8 A. M. saw a ship to windward, steering east.
12	5	2				
1	5	8				
2	5	8				
3	5	5	S. S. E. ½ E.	S. W. by S. ½ W.	1½	
4	5	5				
5	5	5				
6	5	5				
7	5	5				
8	5	5				
9	5	6	S. E. by S.	S. W. by S.	1½	
10	5	6				
11	5	4				
12	5	4				Variation ½ point easterly.

The courses being corrected for lee-way and variation, and the distances summed up (but not doubled since the log-board is marked for every hour) will stand as in the adjoined Traverse Table. Hence the difference of latitude made good is 105.4 S. and the departure 81.7 E. consequently the course is S. 38° E. and the distance 133 miles nearly.

TRAVERSE TABLE.

Courses.	Dist	N.	S.	E.	W.
S.S.E ¾ E.	48		41.2	24.7	
S. E. ¾ S.	31		24.9	18.5	
S. E. ¼ S.	33		24.5	22.2	
S. E. ¼ E.	22		14.8	16.3	
	Diff. Lat.		105.4	81.7	Dep.

Latitude left	35° 46′	N.
Diff. of lat.	1 45	S.
Latitude in	34 1	N.
Sum of lats.	69 47	
Middle lat.	34 53	

With the middle latitude 34° 53′ or 35°, and the departure 81.7, the diff. of long. is found to be 100 miles = 1° 40′ E.

Longitude left	17 42	W.
Longitude in	16 2	W.

To find the bearing and distance of Cape St. Vincents.

Latitude in	34° 1′ N.	Mer. parts	2173	Long. in	16° 2′ W.
C. St. Vincent's lat.	37 1 N.	Mer. parts	2394	C. St. Vin. lon.	9 2 W.
Diff. of lat.	3 0=180′	Mer. diff. lat.	221	Diff. long.	7 0=420′

BY LOGARITHMS.

To find the bearing.

As mer. diff. lat. 221		log.	2.34439
Is to radius	45°		10.00000
So is diff. long.	420	log.	2.62325
To tang. course	62° 15′		10.27886

To find the distance.

As radius	45°	10.00000
Is to prop. diff. lat.	180	2.25527
So is secant course	62° 15′	10.33197
To the distance 386.6		2.58724

Hence the bearing of Cape St. Vincents is N. 62° 15′ E. and distant 386.6 miles.

EXAMPLE III.

Suppose that at the end of the sea day, March 10, 1824, we were in the latitude of 43° 34′ N. and the longitude of 35° E. and have sailed till next noon as per log-board; required the latitude and longitude in, and the variation of the compass?

LOG-BOARD.

H	K.	F.	Courses.	Winds.	L.W	Remarks.
2	4	5	W. S. W.	South.		These 24 hours moderate gales, found a small current setting N. E. at the rate of one mile in 4 hours.
4	4	5				
6	4	5				
8	4					
10	4					
12	4					
2	3	5				
4	3	5	SW by W	S. by E.		
6	3					At 8 A. M. sun's magnetic azimuth N. 125° 19′ E. Alt. of ☉'s L. L. 18° 40′; correction for dip and semi-diameter, 12′ additive.
8	3					
10	3					
12	3	5				

In calculating the variation from the above observation, it is necessary to find the declination and latitude at the time of observation. The former at noon ending the sea-day, March 11, 1824, was 3° 36′ S. by Table IV. the correction for the long. 35° E. is+2′ 14″; and for the time from noon 4h. is+3′ 51″, therefore the whole correction is nearly 6′, which added to 3° 36′ gives the declination at the time of observation 3° 42′ S. consequently the polar distance 93° 42′. To find the latitude we must see by the log-board what courses and distances the ship has sailed from noon to the time of observation at 8 A. M. viz. W. S. W. 58 miles, and S. W. by W. 19 miles; the current setting in the same time N. E. 5 miles; these courses must be corrected for one point westerly variation, which is found to be nearly its value, by a rough calculation made with the latitude in, the preceding noon; and by arranging these courses and distances in a traverse table, we find that the difference of latitude made good at 8 A. M. is about 41 miles, consequently the latitude in at the time of observation is nearly 42° 53′ N. the observed altitude of the sun's L. L. is 18° 40′; the correction for dip and semi-diameter+12′, and the refraction by Table XII.—3′ nearly, consequently the sun's correct altitude is 18° 49′. With these data, the true azimuth is calculated as in page 113.

Polar dist.	93°	42′		
Latitude	42	53	Secant	0.13505
Altitude	18	49	Secant	0.02335
Sum	155	24		
½ Sum	77	42	Co-sine	9.32844
Polar dist.	93	42		
Remainder	16	0	Co-sine	9.98284
			Sum	19.47018
Half sum is log. co-sine	57°	5′		9.73509
		2		
True azimuth	N. 114	10 E.		
Mag. azimuth	N. 125	19 E.		
Variation	11	9 W. or nearly 1 point.		

The variation being allowed on all the courses, and on the set of the current, and the distances being summed up, the traverse table will be as adjoined: and the difference of latitude made good=49.8 S. departure =67.5 W. Hence the course made good S. 53½° W. and distance=84 miles. And by subtracting the difference of latitude 50′ from latitude left 43° 34′, there remains the latitude in 42° 44′ N. Hence we have the middle latitude 43° 9′, with which and the departure 67.5, the difference of longitude is 92′ or 1° 32′ W. nearly: and by subtracting it from the longitude left 35° E. we have the longitude in 33° 28′ E.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S.W. by W.	58		32.2		48.2
S. W.	32		22.6		22.6
N. E. by N.	6	5.0		3.3	
		5.0	54.8	3.3	70.8
			5.0		3.3
	Diff. Lat.		49.8	Dep.	67.5

EXAMPLE IV.

Yesterday at noon we were in the lat. of 40° 19′ N. and in the long. of 67° 58′ W. and have sailed till this noon as per log-book; required the bearing and distance of Cape Cod?

LOG-BOARD.

H	K	F.	Courses.	Winds.	LW	Remarks.
1	1		W.N.W.	North.	1	First part of these 24 hours light breezes
2	1					and fine weather; latter part pleasant
3	1					gales and cloudy.
4	1					
5	2	5				
6	3					
7	1	5				
8	1	5				
9	1	5				
10	1					
11	1		N. W.	N. N. E.	1	Saw great quantities of gulf weed, and rock-
12	1					weed.
1	2	5	N.W.½N.	N.E.½E.	1	
2	2	5				
3	2	5				
4	2	5				
5	3		N. N. W.	N E by E	0	At 7 A. M. water discoloured, sounded no
6	3					bottom.
7	3					
8	3					
9	4					
10	4					
11	4	5		E. N. E.		Latitude by observation 40° 52′ N.
12	4	5				Variation ¾ point W.

The distances are to be summed up, and marked in the traverse table without doubling, because the log-board is marked for every hour. By working this day's work like the others, we find the diff. of latitude made good=31. 6m. N. and the dep. 40. 3m. W. hence the course N. 52° W. nearly, and distance 51 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
W. ¼ N.	15	0.7			15.0
NWbyW¾W	2	0.9			1.8
NWbyW¼W	10	5.1			8.6
N.N.W.¾W.	29	24.9			14.9
	Diff. Lat.	31.6		Dep.	40.3

Latitude left	40°	19′	N.
Diff. of latitude		32	N.
Latitude in by D. R.	40	51	N.
Sum of lats.	81	10	
Middle latitude	40	35	

With the mid. lat. 40½°, and the departure 40.3 the diff. of longitude is 0° 53′ W.

Long. left	67	58	W.
Long. in	68	51	W.

To find the bearing and distance of Cape Cod.

Lat. in by obs.	40°	52′	N.
Lat. of Cape Cod	42	5	N.
Diff. of lat.	1	13=73 miles.	
Mid. lat.	41	28	

Long. in by D. R.	68°	51′	W.
Long. of Cape Cod	70	4	W.
Diff. of long.	1	13=73m.	

With the difference of longitude 73 miles, and the middle latitude 41° 28′, or 41½°, I find the depar. 54.6 nearly, with which, and the difference of lat. 73 miles, the bearing of Cape Cod is found to be N. 37° W. distant 91 miles.

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H.	K.	F.	Courses.	Winds.	L W	Remarks on board, Thursday, Mar. 25, 1824.
1						At noon got under way, with a fine breeze
2						from the N. W.
3						
4						
5						
6						
7						
8						
9	6	5	E. by S.	N.W.		At 8 P. M. Cape Cod light-house bore S.
10	6	5				S. E. ¼ E. distant 12 miles; from which
11	6	5				I take my departure.
12	6	5				
1	6					
2	6					
3	6					
4	6					
5	6	5				
6	6	5				
7	6			North.		
8	6					
9	6					
10	6					
11	7					
12	7					Variation ¾ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
N 86° 58′ E	94	N. 5	E. 94	N. 42° 10′		E. 2° 7′	W. 67° 57′	Funchal S 76° 44′ E distance 2493 miles.

Cape Cod bearing from the ship S. S. E. ¼ E. distant 12 miles, is the same as if the ship had sailed from it 12 miles upon the opposite or N. N. W. ¼ W. point of the compass, and allowing for the variation, it becomes N. W. by N. this and the distance 12 miles, are to be set in the traverse table as the first course and distance.

The ship sailed all day upon an E. by S. course by compass, which, by allowing the variation is E. ¼ S. The whole distance sailed (or the sum of all the distances) is 101 miles. With these course and distances, I find the corresponding differences of latitude and departures; and by subtracting the southing from the northing, and the westing from the easting, find that the difference of latitude made good is 5.0 N. and the departure 94.2 E. which correspond to a course of N. 86° 53′ E. and distance 94 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W
N W by N	12	10.0			6.7
E. ¼ S.	101		5.0	100.9	
		10.0	5.0	100.9	6.7
		5.0		6.7	
	D.Lat.	5.0	Dep.	94.2	

Lat. sailed from, or Cape Cod's lat.	42°	5′ N.
Diff. of lat.	0	5 N.
Latitude in	42	10 N.
Sum of lats.	84	15
Middle latitude	42	7

Then with the middle latitude 42° as a course, I enter Table II. and against the departure 94.2 (or 94.4 which is the nearest tabular number) found in the latitude column, is 127=the difference of longitude in the distance column.

Long. from, or Cape Cod's long.	70°	4′ W.
Diff. Long.	2	7 E.
Long. in	67	57 W.

To find the bearing and distance of Funchal.

Latitude in	42° 10′ N.	Mer. parts	2795	Long. in	67° 57′ W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	16 54 W.
Diff. of lat.	9 32	Mer. diff. lat.	722	Diff. long.	51 3
	60				60
In miles	572			In miles	3063

With the merid. diff. lat. 722 miles, and diff. of long. 3063 miles, the bearing is found to be S. 76° 44′ E. and with this bearing taken as a course, and the proper difference of latitude 572 miles, the distance is found to be 2493 miles, by Case I. of Mercator's sailing.

H	K	F.	Courses.	Winds.	L.W.	Remarks on board, Friday, March 26, 1824.			
1	7		E. by S.	N. by E.		Fresh gales and pleasant weather.			
2	7								
3	7					Saw a number of fishing vessels to the southward.			
4	7								
5	7								
6	7								
7	7		E.by S½S	N.N.E		At noon observed the altitude of the sun's lower limb bearing			
8	7								
9	7					south	50°	27′	N.
10	7					Add for semi-diameter, dip, &c.	0	12	
11	7					Refraction being small is neglected.			
12	7					Correct altitude	50	39	
1	7		E. S. E.			Subtract from	90	00	
2	7								
3	6	6				⊙'s zenith distance	39	21	N.
4	6	6				⊙'s correct declination	2	22	N.
5	6	4							
6	6	4				Latitude by observation	41	43	N.
7	6	4							
8	6	4							
9	6	6							
10	6	6							
11	6	5							
12	6	5				Variation ¾ points westerly.			

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S80°15′E	162	S. 27	E. 160	N. 41° 43	N. 41° 43	E. 3° 35	W. 64° 22	Funchal 76° 27′ E. distance 2326 miles.

The variation being allowed on each course, and the distances summed up, they will stand as in the adjoining traverse table; from hence, by means of Table I. I find the difference of latitude 27,5, and the departure 160,0, which corresponds to the course S. 80° 15′ E. and the distance 162 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. ¼ S.	42		2.1	41.9	
E. ¾ S.	42		6.2	41.5	
E.S.E.¼E.	79		19.2	76,6	
		D.Lat.	27.5	160.0	Dep.

Yesterday's latitude	42°	10′ N.
Diff. of latitude		27 S.
Latitude in	41	43 N.
Sum of latitudes	83	53
Middle latitude	41	56

With the middle latitude 41° 56′ or 42° as a course, I enter Table II. and seek for the departure 160,0 in the latitude column; the nearest number to which is 159.8 corresponding to the distance 215, which is therefore the difference of longitude, equal to 3° 35′ E.

Yesterday's long.	67	57 W.
Long. in	64	22 W.

To find the bearing and distance of Funchal.

Latitude in	41° 43′ N.	Mer. parts	2759	Longitude in	64° 22′ W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	16 54 W.
Diff. of lat.	9 5	M. D. lat.	686	Diff. of long.	47 28
	60				60
In miles	545			In miles	2848

By Case I. of Mercator's sailing, I find the bearing of Funchal to be S. 76° 27′ E. and its distance 2326 miles.

When the sun was upon the meridian, the altitude of his lower limb was 50° 27, to which add 12′ for the semi-diameter, parallax, and the dip of the horizon; the refraction, (given in Table XII.) for this altitude being small, is neglected; hence the correct central altitude was 50° 39′ which subtracted from 90°, leaves the zenith distance 39° 21′ which must be called north, because the sun bore south when on the meridian; then in Table IV. I find the sun's declination at noon at Greenwich=2° 18′ N. to this add the correction 4′ taken from Table V. corresponding to the ship's longitude; the sum is 2° 22′ N.=the correct declination; and since the declination and zenith distance are both north, I add them together, and the sum will be the latitude by observation=41° 43′ N. which agrees with the latitude by account.

H	K	F.	Courses.	Winds.	L W	Remarks on board, Saturday, Mar. 27, 1824.
1	7		E. S. E.	N. by E.		All these 24 hours fresh breezes and
2	7					clear.
3	8					
4	8					
5	8					
6	8					
7	8					Mer. alt. sun's lower limb 51° 48′
8	8					Add for semi-diam. dip, &c. 12
9	8					
10	8					Sun's correct altitude 52 0
11	8					Subtract from 90 00
12	8					
1	8	6		N. N. E.		Sun's zenith distance 38 0 N.
2	8	6				Sun's correct declination 2 46 N.
3	8	6				
4	8	6				Latitude observed 40 46 N.
5	8	6				
6	8	6				
7	8	6				
8	8	6				
9	8	1				
10	7	1				
11	7					
12	7			N E by N		Variation ¼ point westerly, per amplitude.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long	Long. in.	Bearing and Dist.
		S.	E.	N.	N.	E.	W.	Funchal S. 76° 48′
E.S.E¾E.	192	47	186	40° 56	40° 46	4° 8	60° 14′	E. dist. 2137 miles.

TRAVERSE TABLE.

Course.	Dist.	N.	S.	E.	W.
E.S.E.¾E.	192	D.Lat.	46.7	186.2	Dep.

The ship sailed all day upon the same course, which, corrected for the variation, is E. S. E. ¾ E. the whole distance sailed is 192 miles, and the difference of latitude is 47 miles = 0° 47′ S.
Yesterday's latitude 41 43 N.

Latitude by D. R. 40 56 N.

Hence the latitude by account differs 10 miles from the latitude by observation; but it will not be necessary to correct the longitude on account of this error.

Latitude yesterday by obs.	41	43′ N.
Lat. by obs. this day,	40	46 N.
Diff. of lat. by obs.		57
Sum of latitudes	82	29
Middle latitude	41	14

With the middle latitude 41° 14′ as a course, and the departure 186.2 as difference of latitude, I find the corresponding distance 248, which is equal to the difference of longitude 4° 8′ E.
Yesterday's long. 64 22 W.

Long. in 60 14 W.

Note. As this Journal is only designed to exemplify the rules of navigation, we have not endeavoured to give the true variation.

To find the bearing and distance of Funchal.

Latitude in	40° 46′ N.	Mer. parts	2683	Longitude in	60	14′ W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	16	54 W.
Diff. of lat.	8 8	M. D. lat.	610	Diff. long.	43	20
	60				60	
In miles	488			In miles	2600	

With the merid. diff. of lat. and diff. of long. the bearing is found to be S. 76° 48′ E. with that and the proper diff. of lat. the distance is found to be 2137 miles,* by Case I. Mercator.

* If the course was calculated to seconds, and the meridional parts taken to one or two places of decimals, it would sometimes make a difference of a few miles in the calculated distance.

H	K.	F.	Courses.	Winds.	L W	Remarks on board, Sunday, Mar. 28, 1824.
1	7		S E. by E.	NE by E.	1	Fresh gales with rain.
2	7					At 4 A. M. spoke the ship Franklin, from
3	6	6				Philadelphia, bound to Lisbon.
4	6	6				
5	6					
6	6					
7	5	4				
8	5	4				
9	5	6	S. E.	E. N. E.	1	At noon, observed mer. alt.
10	5	6				sun's L. L. 53° 53′
11	5	6				Add for semi-diameter, &c. 0 12
12	5	6				
1	5	3				Sun's correct altitude 54 5
2	5	8				Subtract from 90 00
3	5	5				
4	5	5				Sun's zenith distance 35 55 N.
5	6		SE. by S.	E. by N.	1	Sun's correct declination 3 9 N.
6	6					
7	6					Latitude observed 39 4 N.
8	6					
9	6					
10	6					
11	5					
12	5					Variation ¾ points westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S. 42° 29′ E	138	S. 102	E. 93	N. 39° 4′	N. 39° 4′	E. 2° 2′	W. 58° 12′	Funchal S. 79° 7′ E. distance 2045 miles

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
S. E. ¾ E.	50		29.8	40.2	
S. E. ¼ S.	44		32.6	29.5	
S.S.E. ¾ E.	46		39.5	23.6	
		D. Lat.	101.9	93.3	Dep.

The lee-way and variation being allowed on the courses, they will stand as in the adjoined traverse table. Then with the difference of latitude and departure the course is found to be S. 42° 29′ E. and the distance 138 miles.

Yesterday's latitude	40°	46′	N.
Difference of latitude 102′ =	1	42	S.
Latitude in	39	4	N.
Sum of latitudes	79	50	
Middle latitude	39	55	

With the middle lat. 39° 55′ or 40° as a course, and the dep. 93.3, taken as difference of latitude, the diff. of long. is found to be 122 miles = 2° 2′ E.

Yesterday's longitude	60	14 W.
Longitude in	58	12 W.

The course made good each day is marked in the journal to degrees and minutes, as it was calculated by logarithms; but for practical purposes, it is sufficiently exact to find it to the nearest degree by means of Table II.

To find the bearing and distance of Funchal.

By Case I. Middle Latitude Sailing.

Latitude in	39°	4′ N.	
Funchal's latitude	32	38 N.	
Difference of lat.	6	26	= 386 miles.
Sum of latitudes	71	42	
Middle latitude	35	51	

Longitude in	58°	12′ W.
Funchal's longitude	16	54 W.
Difference of long.	41	18
	60	
In miles	2478	

With the middle latitude 35° 51′ or 36° as a course, and the difference of longitude 2478 as a distance, I calculate the departure; with that and the difference of latitude, I find the distance and course, by Case I. of Middle Latitude Sailing.

H.	K	F.	Courses.	Winds.	L W	Remarks on board, Monday, Mar. 29, 1824.
1	4		South.	E.S.E.	1	These 24 hours moderate, pleasant weather.
2	4					
3	4					
4	4					
5	4					
6	4					
7	4					
8	4					
9	4					Merid. alt. ☉'s lower limb 55° 32'
10	4					Add for semi-diameter, dip, &c. 0 12
11	4					
12	4					☉'s correct altitude 55 44
1	3	6	S. ½ E.	EbS½S	1½	Subtract from 90 00
2	3	6				
3	3	4				☉'s zenith distance 34 16 N.
4	3	4				☉'s correct declination 3 32 N.
5	3					
6	3					Latitude observed 37 48 N.
7	3					
8	3					
9	3					
10	3					
11	3					
12	3					Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
South.	86	S. 86	0	N. 37° 38'	N. 37° 48'	0	W. 58° 12'	Funchal S 81° 17' E. distance 2046 miles.

TRAVERSE TABLE.					
Course.	Dist.	N.	S.	E.	W.
South.	86		86.0 Diff. Lat.		

The lee-way and variation being allowed on both courses, they become south; the whole distance sailed or 86 miles, is therefore the difference of latitude by account, the departure being nothing; consequently the ship is in the same longitude as yesterday.

Yesterday's latitude		39° 4' N.
Difference of latitude	86 =	1 26 S.
Latitude in by D. R.		37 38 N.

The latitude by observation was 37° 48' N. differing 10 miles from the account; but this will not render it necessary to correct the longitude.

To find the bearing and distance of Funchal.

Latitude in	37° 48' N.	Mer. parts	2453	Longitude in	58° 12' W.
Funchal's lat.	32 38 N.	Mer. parts	2073	Funchal's long.	16 54
Diff. of lat.	5 10	Mer. diff. lat.	380	Diff. of long.	41 18
	60				60
In miles	310			In miles	2478

Hence the bearing is found to be S. 81° 17' E. and the distance 2046 miles, by Case I. of Mercator's Sailing; and the same may be found by middle latitude, which is the most exact method when the two latitudes differ but little; and it is the way in which the calculation will be made in the rest of the journal.

H	K.	F.	Courses.	Winds.	L.W	Remarks on board, Tuesday, Mar. 30, 1824.
1	3		East.	N.N E.	3	These 24 hours fresh gales and squally. Handed the fore and main courses.
2	3					
3	3					
4	3					
5	Lay to, up S. E. by E.				5	
6	off S. E. by S. Drift 1½					
7	miles per hour.					
8						
9	Up S. off S. W. Drift				5	
10	1½ miles per hour.					
11						
12						At midnight more moderate; wore ship and set the courses.
1	2	5	E. by N.	SE by S	1½	
2	2	5				
3	3					
4	3					
5	3	5				
6	3	5				At 6 A. M. set the topsails close reefed.
7	2	5				
8	2	5				
9	2	5				
10	2	5				
11	2					
12	2					Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
		N.	E.	N.		E.	W.	Funchal S. 80° 58′ E.
N 76° 17′ E	31	7	30	37° 55′		0° 38′	57° 34′	distance 2017 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. S. E.	12		4.6	11.1	
South.	6		6.0		
W. S. W.	6		2.3		5.5
N.E. ½ E.	32	20.3		24.7	
		20.3	12.9	35.8	5.5
		12.9		5.5	
D. Lat.		7.4	Dep.	30.3	

Taking the middle points, (viz. S. E. and S. S. W.) between the point to which the ship comes to and falls off, as taught in the rules of lying to, and then allowing as before for the variation and lee-way, the traverse table will stand as adjoined.

With the difference of latitude and departure the course is found to be N. 76° 17′ E. and the distance 31 miles.

Yesterday's latitude	37° 48′	N.
Difference of latitude	7	N.
Latitude in	37 55	N.
Sum of latitudes	75 43	
Middle latitude	37 51	

With the middle lat. 37° 51′ (or 38°) as a course, and the departure 30.3 used as difference of latitude, I find the difference of longitude to be 0° 38′ E.

Yesterday's longitude	58 12	W.
Longitude in	57 34	W.

To find the bearing and distance of Funchal.

Latitude in	37° 55′ N.		Longitude in	57° 34′ W.
Funchal's latitude	32 38 N.		Funchal's longitude	16 54 W.
Diff. of latitude	5 17=317	miles.	Diff. of longitude	40 40
Sum of latitudes	70 33			60
Middle latitude	35 16		In miles	2440

With the middle latitude 35° 16′ and the difference of longitude 2440, the departure is found to be 1992; with that and the difference of latitude 317, the bearing of Funchal is found to be S. 80° 58′ E. and the distance 2017 miles.

H.	K.	F.	Courses.	Winds.	L. W.	Remarks on board, Wednesday, Mar. 31, 1824.
1	5		E. S. E.	South.	1	Pleasant gales and fair weather.
2	5					
3	5					
4	5					
5	5	6				
6	5	6				
7	5	4				
8	5	4				
9	5	5				
10	5	5	E by S ½ S	S. ½ E.	½	
11	6					
12	6					
1	7					
2	7					
3	7					
4	7					
5	7					
6	7					
7	7					
8	7					
9	7					
10	7					
11	8					
12	8					Variation 1 point westerly per azimuth.

Course	Dist	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
East.	151	0	E. 151	N. 37° 55′		E. 3° 11′	W. 54° 23′	Funchal S. 80° 12′ E. dist. 1868 miles.

The variation and lee-way being allowed on both courses, it appears that the ship has made a due east course, the distance sailed 151 miles is the departure, and the difference of longitude is found by Case II. of Parallel Sailing. The latitude in is the same as yesterday's lat. 37° 55′ N. Taking this as a course, and the departure 151 as difference of latitude, the distance which corresponds is the difference of longitude, 191 miles = 3° 11′ E.

Yesterday's longitude	57	34	W.
Longitude in	54	23	W.

To find the bearing and distance of Funchal.

Latitude in	37° 55′ N.		Longitude in	54° 23′ W.
Funchal's lat.	32 38 N.		Funchal's long.	16 54 W.
Diff. of latitude	5 17 = 317 miles.		Diff. of long.	37 29 W.
				60
Sum of latitudes	70 33			
Middle latitude	35 16		In miles	2249

Hence by case I. of Middle Latitude Sailing, the departure is found to be 1836 miles, the bearing of Funchal S. 80° 12′ E. and the distance 1868 miles.

H.	K	F.	Courses.	Winds.	L W	Remarks on board, Thursday, April 1, 1824.
1	8		E. S. E.	S.S.W		Fresh gales and pleasant weather.
2	8					
3	8					
4	8					
5	8	4				
6	8	4				
7	8	6				Obs. mer. alt. sun's lower limb 56° 59′
8	8	6				Correct for semi-diam. dip, &c. 12
9	8	5				
10	8	5				Sun's correct altitude 57 11
11	8	5				Subtract from 90 00
12	8	5				
1	9		EbyS ½ S	S by W		Sun's zenith distance 32 49 N.
2	9					Sun's declination 4 41 N.
3	9					
4	9			South.		Latitude observed 37 30 N.
5	8	6				
6	8	6				
7	8	4				
8	8	4				
9	8	5	East.	S.by E.	½	
10	8	5				
11	9					
12	9					Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S 85° 24′ E.	202	S. 16	E. 201	N. 37° 39′	N. 37° 30′	E. 4° 15′	W. 50° 8′	Funchal, S. 79° 51′ E. distance 1658 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. by S.	100		19.5	98.1	
E. ¼ S.	70		6.9	69.7	
E.N.E.¼E.	35	10.2		33.5	
		10.2	26.4	201.3	Dep.
			10.2		
	Diff. Lat.		16.2		

The courses being corrected for lee-way and variation, the traverse table will be as here given.

Hence the course is S. 85° 24′ E. distance 202 miles.

Yesterday's latitude	37° 55′	N.
Diff. of latitude	16	S.
Lat. in by account	37 39	N.
Yesterday's long.	54 28	W.
With the mid. lat. 37° 42′ and the dep. 201.3, the diff. of long. is 255=	4 15	E.
Longitude in by account	50 8	W.

The latitude by observation differs 9 miles from the latitude by dead reckoning, but the longitude requires no correction on this account.

H	K.	F.	Courses.	Winds.	L W	Remarks on board. Friday, April 2, 1824.
1	6	5	E. S. E.	South.	½	Fresh gales, with rain.
2	6	5				
3	7	5				
4	7	5				
5	7					
6	7					
7	8		E. S. E.	S. W.	0	
8	8					
9	8	5				Saw a ship to the southward.
10	8	5				This day took a lunar observation, by mea-
11	8	5				suring the distance of the moon from the star
12	8	5				Pollux, the longitude at noon, deduced from
1	9					this observation, was 45° 50′ W.
2	9					
3	9					
4	9					
5	9					
6	9					
7	9					
8	9					
9	9	5				
10	9	5				
11	9	5				
12	9	5				Variation 1 point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long	Long. in.	Bearing & Dist.
S 79°56′E	202	S. 35	E. 199	N. 36° 55′		E. 4° 9′	W. 45° 59′	Funchal S. 79°50′E. dist. 1456 miles.

TRAVERSE TABLE.					
Courses.	Dist.	N.	S.	E.	W.
E. ¼ S.	42		4.1	41.8	
E. by S.	160		31.2	156.9	
		D.Lat.	35.3	198.7	Dep.

The lee-way and variation being allowed on the courses, the traverse table will be as here given; hence the course was S. 79° 56′ E. and the distance 202 miles.

Yesterday's latitude	37°	30′	N.
Difference of latitude		35	
Latitude in	36	55	N.
Sum of latitudes	74	25	
Middle latitude	37	12	

With the middle lat. 37° 12′ and the dep. 198.7, the difference of longitude is found to be 249 miles = 4° 9′ E.

Yesterday's longitude	50	8	W.
Longitude in	45	59	W.

To find the bearing and distance of Funchal.

Latitude in	36°	55′	N.	Longitude in	45°	59′	W.
Funchal's latitude	32	38	N.	Funchal's longitude	16	54	W.
Diff. of latitude	4	17 = 257 m.		Diff. of longitude	29	5	
					60		
Sum of latitudes	69	33					
Middle latitude	34	46		In miles	1745		

Hence by Case I. of Middle Latitude Sailing, the bearing of Funchal is found to be S. 79° 50′ E. and its distance 1456 miles.

H	K.	F.	Courses	Winds.	L W	Remarks on board, Saturday, April 3, 1824.
1	9	0	E. S. E.	West.		Fresh gales and rainy weather; latter part clear.
2	9	6				
3	9	4				A great swell from the N. E. for which I allow 9 miles.
4	9	4				
5	9					
6	9					
7	9					
8	9					
9	9	5				Obs. alt. sun's lower limb at noon 58° 58′
10	9	5				Correct. for semi-diam. &c. add 0 12
11	9	5				
12	9	5				Sun's correct altitude 59 10
1	9					Subtract from 90 00
2	9			N. W.		
3	9					Sun's zenith distance 30 50 N.
4	9					Sun's declination 5 27 N.
5	9					
6	9					Latitude observed 36 17 N.
7	9					
8	9					
9	9					
10	9			North.		
11	9					
12	9					Variation 1¼ point westerly per azimuth.

Course.	Dist.	Diff. Lat.	Dep	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S79°22′E.	217	S. 40	E. 213	N. 36° 15′	N. 36° 17′	E. 4° 25′	W. 41° 34′	Funchal S. 79° 50′ E. dist. 1240 miles.

TRAVERSE TABLE.

Courses.	Dist	N.	S.	E.	W.
E.¾S.	220		32.3	217.6	
SSW.¾W	9		7.7		4.6
		D.lat	40.0	217.6	4.6
				4.6	
			Dep.	213.0	

In this day's work the swell is considered as a current setting the ship 9 miles per day; and since the swell comes from the N. E. it must set the ship S. W. and allowing the variation S. S.W.¾ W. 9 miles, these are placed as a course and distance in the traverse table.

With the difference of latitude and departure the course is found to be S. 79° 22′ E. and the distance 217 miles.

With the middle lat. 36°36′, and the dep. 213 miles, the diff. of long. is found 265 miles= 4° 25′ E.

Yesterday's long.	45 59	W.
Longitude in	41 34	W.

Yesterday's latitude	36° 55′	N.
Difference of latitude	40	S.
Latitude in	36 15	N.

To find the bearing and distance of Funchal.

Latitude in	36° 17′	N.
Funchal's latitude	32 38	N.
Difference of latitude	3 39=219 m.	
Sum of Latitudes	68 55	
Middle latitude	34 27	

Longitude in	41° 34′	W.
Funchal's longitude	16 54	W.
Diff. of Long.	24 40	
	60	
In miles	1480	

Hence by Case I. Middle Latitude Sailing, the bearing of Funchal is found to be S. 79° 50′ E. and its distance 1240 miles.

To find the bearing and distance of Funchal by Mercator's Chart.

Having pricked off the place of the ship at noon, lay a ruler from that poing to Funchal; take the nearest distance between the centre of the compass and the ruler; then slide one foot of the compasses along the edge of the ruler, keeping the other foot at the greatest distance from it, and it will be found to run nearly upon the E. by S. line, which is therefore the bearing of Funchal: then take in your compasses the extent from the place of the ship to Funchal, and apply it to the graduated meridian, setting one foot as much above one place as the other is below the other place, and the extent will be found to measure 20½ degrees, or 1230 miles, which was the distance of the ship from Funchal nearly.

H	K	F.	Courses	Winds	L W	Remarks on board, Sunday, April 4, 1824.	
1	7	4	E. S. E.	N. E.	1	First part fresh gales; latter part more moderate, a heavy sea running.	
2	7	4					
3	6	6					
4	6	6					
5	6						
6	6					Mer. alt. sun's lower limb	61° 3′
7	5	4	S. E.	E.N.E	1	Correction for semi-diameter, &c.	0 12
8	5	4					
9	4	6				Sun's correct altitude	61 15
10	4	6				Subtract from	90 00
11	4		S. S. E.	East.	1		
12	4					Sun's zenith distance	28 45 N.
1	4		S. by E.	E.byS.	1¼	Sun's declination	5 50 N.
2	4						
3	4					Latitude observed	34 35 N.
4	4						
5	4	5	S. by E.		1½		
6	4	5					
7	4						
8	4						
9	4						
10	4						
11	4						
12	4					Variation 1¼ points westerly.	

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist
S. 37°45′E	104	S. 82	E. 64	N. 34° 55′	N. 34° 35′	E. 1° 18′	W. 40° 16′	Funchal S. 84° 17 E. dist. 1174 miles

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. S. E. ¼ E.	40		13.5	37.7	
S. E. ¼ E.	20		13.4	14.8	
S. S. E. ¼ E.	8		7.2	3.4	
S. by E.	16		15.7	3.1	
S. ¾ E.	33		32.6	4.8	
	Diff. Lat.		82.4	63.8	

The courses being corrected for lee-way and variation, will stand as in the adjoined traverse table.

Then with the difference of latitude 82.4 & the departure 63.8, I find the course S. 37° 45′ E.

Yesterday's latitude	36° 17′ N.
Difference of latitude	1 22′ S.
Lat. by account	34 55 N.

Yesterday's latitude	36° 17′ N.
Latitude in by obs.	34 35 N.
Sum of latitudes	70 52
Middle latitude	35 26

With the dep. 63.8 miles, and the mid. lat. 35° 26′, I find the diff. of long. to be 78 miles = 1° 18′ E.

Yesterday's long.	41 34 W.
Longitude in	40 16 W.

To find the bearing and distance of Funchal.

Latitude in	34° 35′ N.
Funchal's latitude	32 38 N.
Diff. of latitude	1 57 = 117 miles.
Middle latitude	33 36

Longitude in	40° 16′ W.
Funchal's longitude	17 54 W.
Diff. of longitude	23 22
	60
In miles	1402

Hence by Case I. Middle Latitude Sailing, the bearing of Funchal is found to be S. 84° 17′ E. and its distance 1174 miles.

H.	K.	F.	Courses.	Winds.	L W	Remarks on board, Monday, April 5, 1824.
1	3		S. E.	E.N.E	1	First part of these 24 hours small breezes,
2	3					and calm; latter part fresh gales.
3	2					At 4 P. M. got out the boat and tried the
4	2					current; found it running E. 1 mile per
5						hour, and suppose the ship has been in this
6			Calm.			current these 24 hours.
7						
8						
9						
10						Mer. alt. sun's lower limb 61° 39′
11						Correction for semi-diam. &c. 0 12
12						
1	3	4	E. S. E.	N.N.E		Sun's correct altitude 61 51
2	3	4				Subtract from 90 00
3	4	6				
4	4	6				Sun's zenith distance 28 9 N.
5	5	5				Sun's declination 6 12 N.
6	5	5				
7	6	5				Observed latitude 34 21 N.
8	6	5				
9	7					
10	7					
11	8					
12	8					Variation 1¼ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S. 83° 36′ E	101	S. 11	E. 100	N. 34° 24′	N. 34° 21′	E. 2° 1′	W. 38° 15′	Funchal S 84° 30′ E distance 1078 miles.

TRAVERSE TABLE.

Courses.	Dist	N.	S.	E.	W.
S. E. ¼ E.	10		6.7	7.4	
E. ¾ S.	70		10.3	69.2	
E.N.E.¾E.	24	5.8		23.3	
		5.8	17.0	99.9	Dep.
			5.8		
	Diff. Lat.		11.2		

In addition to the courses sailed, I also allow 24 miles for the set of the current in the direction of east per compass, or E. N. E. ¾ E. true course.

With the difference of latitude 11.2 and the departure 99.9, the course is found to be S. 83° 36′ E. and the distance nearly 101 miles.

Yesterday's latitude	34° 35′ N.	
Difference of latitude	0 11 S.	
Latitude in by account	34 24 N.	

With the middle lat. 34° 28′, and the dep. 99.9, I find the diff. of long. to be 121 miles= 2° 1′ E.

Yesterday's longitude	40 16 W.
Longitude in	38 15 W.

To find the bearing and distance of Funchal.

Latitude in	34° 21′ N.	Longitude in	38° 15′ W.
Funchal's latitude	32 38 N.	Funchal's longitude	16 54 W.
Difference of lat.	1 43=103 miles.	Difference of long.	21 21
Sum of latitudes	66 59		60
Middle latitude	33 30 nearly.	In miles	1281

Hence by Case I. of Middle Latitude Sailing, the bearing of Funchal is found to be S. 84° 30′ E. and its distance 1078 miles.

H	K	F.	Courses.	Winds	L W	Remarks on board, Tuesday, April 6, 1824.	
1	9		E. S. E.	North.		Fine fresh gales and clear weather.	
2	9						
3	9						
4	9						
5	9						
6	9						
7	9					Mer. alt. sun's lower limb	62° 35′
8	9					Correction for dip, &c.	0 12
9	9						
10	9					Sun's correct altitude	62 47
11	9					Subtract from	90 00
12	9						
1	9					Sun's zenith distance	27 13 N.
2	9					Sun's declination	6 35 N.
3	9						
4	9					Observed latitude	33 48 N.
5	9						
6	9						
7	9						
8	9						
9	9						
10	9						
11	9						
12	9					Variation per Amp. 1¼ point westerly.	

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
E. ¾ S.	216	S. 32	E. 214	N. 33° 49′	N. 33° 48′	E. 4° 18′	W. 33° 57′	Funchal S. 85° 19′ E. dist. 859 miles.

The course corrected for variation is E. ¾ S. distance 216 miles; hence the difference of latitude is 31.7, and the departure 213.7 miles.

Yesterday's latitude	34° 21′ N.
Difference of latitude	32 S.
Latitude in	33 48 N.
Sum of latitudes by obs.	68 9
Middle latitude	34 4

With the middle latitude 34° 4′, and the departure 213.7 miles, I find the difference of longitude to be 258 miles= 4° 18′ E.

Yesterday's longitude	38 15 W.
Longitude in	33 57 W.

To find the bearing and distance of Funchal.

Latitude in	33° 48′ N.	Longitude in	33° 57′ W.
Funchal's lat.	32 38 N.	Funchal's long.	16 54 W.
Diff. of latitude	1 10=70 miles.	Diff. of long.	17 3 W.
Sum of latitudes	66 26		60
Middle latitude	33 13		
		In miles	1023

Hence the bearing of Funchal is found to be S. 85° 19′ E. and its distance 859 miles.

H	K	F.	Courses.	Winds.	LW.	Remarks on board, Wednesday, Ap. 7, 1824.
1	10		E.S.E.	NNW.		Fresh gales and pleasant weather, with a large sea.
2	10					
3	10					At 4 P. M. took a lunar observation by measuring the distance of the moon from the sun; the longitude reduced to noon by the log, was 29° 39′ W.
4	10					
5	10					
6	10					
7	8	4	E.S.E½S	North.		
8	8	4				
9	8	6				
10	8	6				
11	8	5				
12	8	5				
1	8					
2	8					
3	8	5				
4	8	5				
5	8	4				
6	8	4				
7	8	6				
8	8	6				
9	8					
10	8					
11	8					
12	8					Variation per azimuth 1½ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S80°20′E	210	S. 35	E. 207	N. 33° 13′		E. 4° 8′	W. 29° 49′	Funchal S 86° 55′ E distance 652 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. ½ S.	60		5.9	59.7	
E. by S.	150		29.3	147.1	
			35.2	206.8	

By the adjoined traverse table, the difference of latitude is 35.2, and the departure 206.8; hence the course was S. 80° 20′ E. and the distance 209.8, or 210 miles.

Yesterday's latitude	33° 48′ N.		
Difference of latitude	35′ S.		
Latitude in by account	33 13′ N.		
Sum of latitudes	67 1		
Middle latitude	33 30		

With the middle latitude 33° 30′ and the departure 206.8, I find the diff. of long. 248 miles, or 4° 8′ E.

Yesterday's longitude	33 57 W.
Longitude in	29 49 W.

To find the bearing and distance of Funchal.

Latitude in	33° 13′ N.	Longitude in	29° 49′ W.
Funchal's latitude	32 38 N.	Funchal's longitude	16 54 W.
Diff. of latitude	35	Diff. of longitude	12 55
Sum of latitudes	65 51		60
Middle latitude	32 55		
		In miles	775

Hence the bearing of Funchal is found to be S. 86° 55′ E. and its distance 652 miles.

H	K	F.	Courses.	Winds.	L W	Remarks on board, Thursday, Ap. 8, 1824.
1	8		E.by S½S	N.N.E		First part fresh gales and clear. Latter part rainy weather.
2	8					
3	8	5				
4	8	5				
5	8	5				
6	8	5				
7	8		S. E.	E.N.E	½	
8	8					
9	8					
10	8					
11	8					
12	8					At 6 A. M. the wind hauled suddenly to the S. S. E.
1	8					
2	8					
3	8					
4	8					
5	7	5	East.	S.S.E.	¾	
6	7	5				
7	7	5				
8	7	5				
9	7	5				
10	7	5				
11	7	5				
12	7	5				Variation 1½ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat.by D.R.	Lat.by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S83°45'E	172	S. 19	E. 171	N. 32° 54'		E. 3° 24'	W. 26° 25'	Funchal S. 88° 5' E. dist. 480 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
East.	50			50.0	
S. E. by E.	80		44.4	66.5	
NE.byE¾E	60	25.7		54.2	
		25.7	44.4	170.7	Dep.
			25.7		
	Diff. Lat.		18.7		

The leeway and variation being allowed on the courses, they will stand as in the adjoined traverse table; then with the difference of latitude 18.7, and the departure 170.7, the course is found to be S. 83° 45' E. and the distance 172 miles.

Yesterday's latitude	33° 13'	N.
Difference of latitude	19	S.
Latitude in	32 54	N.
Sum of latitudes	66 7	
Middle latitude	33 3	

With the middle lat. 33° 3' and the dep. 170.7, I find the diff. of long. is nearly 204 miles= 3° 24' E.

	3° 24'	E.
Yesterday's longitude	29 49	W.
Longitude in	26 25	W.

To find the bearing and distance of Funchal.

Latitude in	32° 54'	N.
Funchal's latitude	32 38	N.
Diff. of latitude	16	
Sum of latitudes	65 32	
Middle latitude	32 46	

Longitude in	26° 25'	W.
Funchal's longitude	16 54	W.
Diff. of longitude	9 31	
	60	
In miles	571	

Hence the bearing of Funchal is found to be S. 88° 5' E. and its distance 480 miles.

H	K.	F.	Courses.	Winds.	L W	Remarks on board, Friday, April 9, 1824.		
1	7	5	E.by S.¾S	South.		Fine breezes, with variable weather.		
2	7	5						
3	8							
4	8							
5	8	5				Mer. alt. sun's lower limb	64°	33′
6	8	5				Correction for dip, &c.	0	12
7	9							
8	9					Sun's correct altitude	64	45
9	9					Subtract from	90	00.
10	9							
11	9					Sun's zenith distance	25	15 N.
12	9					Sun's declination	7	41 N.
1	9							
2	9					Observed latitude	32	56 N.
3	9		E. by S.					
4	9							
5	9							
6	9							
7	9							
8	9							
9	9							
10	9							
11	9							
12	9					Variation 1½ point westerly.		

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
N89°12′E	210	N. 3	E. 209	N. 32° 57′	N. 32° 56′	E. 4° 10′	W. 22° 15′	Funchal, S. 86° 11′ E. distance 270 miles.

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E. ¼ S.	120		5.9	119.9	
E. ½ N.	90	8.8		89.6	
		8.8	5.9	209.5	Dep.
		5.9			
Diff. Lat.		2.9			

The variation being allowed on the courses, they will stand as in the adjoined table; then with the difference of latitude 2.9, and the departure 209.5, the course is found to be N. 89° 12′ E. and the distance 210 miles nearly.

Yesterday's latitude	32°	54′ N.
Difference of latitude		3 N.
Latitude by account	32	57 N.

With the middle lat. 32° 55′, and the dep. 209.5, the diff. of long. is

found 250 miles=	4°	10′ E.
Yesterday's longitude	26	25 W.
Longitude in	22	15 W.

To find the bearing and distance of Funchal.

Latitude in	32°	56′ N.
Funchal's latitude	32	38 N.
Difference of latitude		18
Sum of latitudes	65	34
Middle latitude	32	47

Longitude in	22°	15′ W.
Funchal's longitude	16	54 W.
Difference of longitude	5	21
	60	
In miles	321	

Hence the bearing of Funchal is found to be S. 86° 11′ E. and its distance 270 miles.

H	K.	F.	Courses.	Winds.	L.W.	Remarks on board, Saturday, Apr. 10, 1824.
1	9	5	S E by E	S.S.W.		All this day fine breezes, with very clear weather.
2	9	5				
3	9	5				
4	9	5				
5	9	5				
6	9	5				
7	9					
8	9					
9	9					
10	9					
11	9					
12	9					
1	9		E by S¾S			
2	9					At 10 A. M. made the land. The southern part of Madeira bearing per compass E. by S. ¾ S. distant 19 leagues.
3	9					
4	9					
5	9					
6	9					
7	9					
8	9					
9	9					
10	9					
11						
12						Variation 1¾ point westerly.

Course.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bearing and Dist.
S83°57′E	256	S. 27	E. 255	N. 32° 29′		E. 5° 3′	W. 17°12′	

TRAVERSE TABLE.

Courses.	Dist.	N.	S.	E.	W.
E.S.E.¾E.	111		27.0	107.7	
East.	90			90.0	
East.	57			57,0	
			27.0	254.7	

In the traverse table are placed the bearing and distance of the land at 10 A. M. (after allowing the variation.) Hence the whole difference of latitude is 27 miles, the departure 254.7, the course S. 83° 57′ E. and the distance 256 miles.

Yesterday's latitude	32° 56′	N.
Difference of latitude	27	S.
Latitude by account	32 29	N.
Sum of latitudes	65 25	
Middle latitude	32 42	

With the middle lat. 32° 42′, and the dep. 254.7, the diff. of long. is found to be

303 miles=	5° 3′	E.
Yesterday's long.	22 15	W.
	17 12	W.

Therefore the latitude of the southern point of Madeira by my account is 32° 29′ N. and its longitude 17° 12′ W. these values differing but little from the values given in the table of latitudes and longitudes; I therefore conclude, that my journal was nearly exact; and that latitude and longitude of that part of Madeira were well laid down.

H	K.	F.	Courses.	Winds.	L. W.	REMARKS on board, Sunday, April 11, 1824.
1						Pleasant gales and fair weather.
2						
3						
4						At 4 P. M. came to, off Funchal.
5						
6						
7						
8						
9						At 8 P. M. went on shore.
10						
11						
12						

Courses.	Dist.	Diff. Lat.	Dep.	Lat. by D. R.	Lat. by Obs.	Diff. Long.	Long. in.	Bear. and Dist.

AN ABSTRACT OF THE FOREGOING JOURNAL.

Days.	Months. 1824.	Courses.	Dist.	Lat. by D. R.	Lat. by Ob.	Long. in.	Bearings and Distances of Funchal at noon.
Thursday,	March 25	N. 86° 58′ E.	94	42° 10′ N.		67° 57′ W.	S. 76° 44′ E. distant 2493 miles.
Friday,	March 26	S. 80 15 E.	162	41 43	41° 43′ N.	64 22	S. 76 27 E. distant 2326 miles.
Saturday,	March 27	S. 75 56 E.	192	40 56	40 46	60 14	S. 76 48 E. distant 2137 miles.
Sunday,	March 28	S. 42 29 E.	138	39 4	39 4	58 12	S. 79 7 E. distant 2045 miles.
Monday,	March 29	South.	86	37 38	37 48	58 12	S. 81 17 E. distant 2046 miles.
Tuesday,	March 30	N. 76 17 E.	31	37 55		57 34	S. 80 58 E. distant 2017 miles.
Wednesday,	March 31	East.	151	37 55		54 23	S. 80 12 E. distant 1863 miles.
Thursday,	April 1	S. 85 24 E.	202	37 39	37 30	50 8	S. 79 51 E. distant 1658 miles.
Friday,	April 2	S. 79 56 E.	202	36 55		45 59	S. 79 50 E. distant 1456 miles.
Saturday,	April 3	S. 79 22 E.	217	36 15	36 17	41 34	S. 79 50 E. distant 1240 miles.
Sunday,	April 4	S. 37 45 E.	104	34 55	34 35	40 16	S. 84 17 E. distant 1174 miles.
Monday,	April 5	S. 83 36 E.	101	34 24	34 21	38 15	S. 84 30 E. distant 1073 miles.
Tuesday,	April 6	E. ½ S.	216	33 49	33 48	33 57	S. 85 19 E. distant 859 miles.
Wednesday,	April 7	S. 80 20 E.	210	33 13		29 49	S. 86 55 E. distant 652 miles.
Thursday,	April 8	S. 83 45 E.	172	32 54		26 25	S. 88 5 E. distant 480 miles.
Friday,	April 9	N. 89 12 E.	210	32 57	32 56	22 15	S. 86 11 E. distant 270 miles.
Saturday,	April 10	S. 83 57 E.	256	32 29		17 12	made the land, bearing E. by S. ½ S. dist. 19 leag.
Sunday,	April 11	Came to anchor at 4 P. M. in Funchal road.					

EXPLANATION OF SEA TERMS.

ABACK. The situation of the sails, when their surfaces are pressed aft against the mast by the force of the wind.

Abaft or aft. The sternmost part of the ship; *Carry aft any thing;* that is, carry towards the stern. *The mast rakes aft;* that is, hangs towards the stern. *How cheer ye fore and aft?* that is, how fares all the ship's company?

Abaft the Beam denotes the relative situation of any object with the ship, when the object is placed in any part of that arch of the horizon, which is contained between a line at right angles with the keel, and that point of the compass which is directly opposite to the ship's course. See Bearing.

Aboard. The inside of a ship. *Aboard Main Tack!* The order to draw the lower corner of the mainsail down to the chestree.

About. The situation of a ship as soon as she has tacked or changed her course.

About ship! the order to the ship's crew to prepare for tacking.

Abreast. The situation of two or more ships lying with their sides parallel, and their heads equally advanced; in which case they are abreast of each other.

Adrift. The state of a ship broken from her moorings, and driving about without control.

Afloat. Buoyed up by the water from the ground.

Afore. All that part of a ship which lies forward or near the stem. It also signifies further forward.

After. A phrase applied to any object in the hinder part of the ship, as the after-hatchway, the after-sails, &c.

Aground. The situation of a ship when her bottom or any part of it rests on the ground.

A-head. Any thing which is situated on that point of the compass to which a ship's stem is directed, is said to be ahead of her. See Bearing.

A-hull. The situation of a ship when all her sails are furled and her helm is lashed to the lee side; by which she lies nearly with her side to the wind and sea, her head being somewhat inclined to the direction of the wind.

A-lee. The position of the helm when it is put down to the lee side.

All in the wind. The state of a ship's sails, when they are parallel to the direction of the wind, so as to shake or shiver.

All-hands-ahoy! The call by which all the ship's company are summoned upon deck.

Aloft. Up in the tops, at the mast heads, or any where about the higher rigging.

Along-side. Side by side, or joined to a ship, wharf, &c.

Along-shore. Along the coast; a course which is in sight of the shore, and nearly parallel to it.

Aloof is distance. Keep aloof, that is, keep at a distance.

Amain. The old term for yield, used by a man of war to an enemy; but it now signifies any thing done suddenly, or at once, by a number of men.

Amidships. The middle of a ship, either with regard to her length or breadth.

Anchor. The instrument by which a ship is held. *The anchor is foul;* that is, the cable has got about the fluke of the anchor. *The anchor is a-peak;* that is, directly under the hawse-hole of the ship. *The anchor is a cock bill;* that is, hangs up and down the ship's side.

An-end. The position of any mast, &c. when erected perpendicularly on the deck. The top-masts are said to be an end, when they are hoisted up to their usual station.

A-peak. Perpendicular to the anchor; the cable having been drawn so tight as to bring the ship directly over it. The anchor is then said to be a-peak.

Ashore. On the shore, as opposed to aboard. It also means aground.

Astern. Any distance behind a ship, as opposed to ahead. See Bearing.

At Anchor. The situation of a ship riding by her anchor.

Athwart. Across the line of a ship's course. *Athwart Hawse;* the situation of a ship when driven by accident across the fore part of another; whether they touch, or are at a small distance from each other, the transverse position of the former being principally understood. *Athwart the Fore Foot;* when any object crosses the line of a ship's course, but ahead of her, it is said to be athwart the Fore Foot. *Athwart ships;* reaching, or in a direction, across the ship from one side to the other.

Atrip. When applied to the anchor, it means that the anchor is drawn out of the ground, and hangs in a perpendicular direction, by the cable or buoy rope. The top-sails are said to be atrip, when they are hoisted up to the mast head, or to their utmost extent.

Avast. A term used for stop, or stay; as, *avast heaving,* do not heave any more.

Aweigh. The same as atrip when applied to the anchor.

Awning. A shelter or screen of canvass spread over the decks of a ship, to keep off the

the heat of the sun. *Spread the awning;* extend it so as to cover the deck. *Furl the awning;* that is, roll it up.

To back the Anchor. To carry out a small anchor ahead of the large one, in order to support it in bad ground, and to prevent it from loosening or coming home.

To back astern. In rowing, is to impel the boat with her stern foremost, by means of the oars.

To back the sails. To arrange them in a situation that will occasion the ship to move astern.

To bagpipe the mizen. To lay it aback, by bringing the sheet to the mizen shrouds.

To balance. To contract a sail into a narrower compass, by folding up a part at one corner. Balancing is peculiar only to the mizen of a ship, and the mainsail of those vessels wherein it is extended by a boom.

Bale. Bale the boat; that is, to throw the water out of her.

Ballast, is either pigs of iron, stones or gravel, which last is called shingle ballast; and its use is to bring the ship down to her bearings in the water, which her provisions and stores will not do. *Trim the ballast;* that is, spread it about and lay it even. *The Ballast shoots;* that is, it shifts, or runs over from one side of the hold to the other.

Bare poles. When a ship has no sail set, she is under bare poles.

Barge. A carval built boat, that rows with ten or twelve oars.

Batten. A thin piece of wood. Batten down the hatches, is to lay battens upon the tarpaulins, which are over the hatches in bad weather, and nail them down that they may not be washed off.

Beacon. A post or stake erected over a shoal or sand bank, as a warning to seamen to keep at a distance. Also, a signal placed at the top of hills, &c.

Beams. Strong pieces of timber stretching across a ship's side to side, to support the decks, and retain the sides at their proper distance.

Bear a-hand. Make haste, despatch.

Bearing signifies the point of the compass which any two or more places bear from each other, or how any place bears from the ship by the compass; or it may be said to bear on the beam, abaft the beam, on the bow, the head or stern, &c.

Bearings of a ship, is that line which is formed by the water upon her sides when she is at anchor, with her proportion of ballast and stores on board. To bear to, is to sail into an harbour, &c. Bear round up; that is, put her right before the wind. Bring your guns to bear, is to point them to the object.

To bear in with the land, is when a ship sails towards the shore.

To Bear off. To thrust or keep off from the ship's side, &c. any weight when hoisting.

Bearing up or *Bearing away.* The act of changing the course of a ship, in order to make her run before the wind, after she had sailed sometime with a side wind, or close hauled; it is generally performed to arrive at some port under the lee, or to avoid some imminent danger occasioned by a violent storm, leak, or enemy in sight.

Beating to Windward. The making a progress against the direction of the wind, by steering alternately close hauled on the starboard and larboard tacks.

To becalm. To intercept the current of the wind; in its passage to a ship, by any contiguous object, as a shore above her sails, a high sea behind, &c. and thus one sail is said to becalm another.

Before the Beam, denotes an arch of the horizon comprehended between the line of the beam (which is at right angles to the keel) and that point of the compass on which the ship stems. See Bearing.

Belay. To make fast any running rope, as Belay the main brace, or make it fast.

Bend. To apply to and fasten; as, bend the sails, apply them to the yards and fasten them: unbend the sails, that is, cast them off, and take them from the yards; her sails are unbent, she has none fixed: bend the cable, make it fast to the anchor.

Beneaped. See Neaped.

Between Decks. The space contained between any two decks of a ship.

Bight of a rope. The double part of a rope when it is folded. Bight, a narrow inlet of the sea.

Bilge. To break. The ship is bilged; that is, her planks are broken in by violence.

Bilge-Water, is that which, by reason of the flatness of a ship's bottom, lies on her floor, and cannot go to the well of the pump.

Binnacle. A kind of box to contain the compasses in upon deck.

Birth. A place; as *the ship's birth,* the place where she is moored; *an officer's birth,* his place in the ship to eat or sleep in; *birth the ship's company,* that is, allot them their places to mess in; *birth the hammocks,* point out where each man's hammock is to hang.

Bitts. Very large pieces of timber in the fore part of a ship, round which the cables are fastened when the ship is at anchor. After-Bitts, a smaller kind of bitts upon the quarter-deck, for belaying the running rigging to.

To Bitt the Cable, is to confine the Cable to the bitts, by one turn under the cross piece,

and another turn round the bitt-head. In this position it may be either kept fixed, or it may be veered away.

Bitter. The turn of the cable round the bitts. *Bitter end;* that part of the cable which stays within board, round about the bitts, when the ship is at anchor.

Block. A piece of wood with running sheaves or wheels in it, through which the running rigging is passed to add to the purchase.

Board. To board a ship is to enter it in a hostile manner.

Board. To make *a board* is making a stretch upon any tack when a ship is working upon a wind. *To board it up,* that is, to turn to windward. *The ship has made a stern board,* that is, when she loses ground in working upon a wind.

Boatswain. The officer who has charge of all the cordage, rigging, anchors, &c.

Bold shore. A steep coast, permitting the close approach of shipping.

Bolt rope. The rope which goes round a sail, and to which the canvass is sewed. The side ropes are called *leach ropes,* that at the top the *head rope,* and that at the bottom the *foot rope.*

Bonnet of a sail, is an additional piece of canvass put to the sail in moderate weather to hold more wind. *Lase on the bonnet,* that is, fasten it to the sail. *Shake off the bonnet,* take it off.

Boot topping. Cleaning the upper part of a ship's bottom, or that part which lies immediately under the surface of the water, and daubing it over with tallow, or with a mixture of tallow, sulphur, rosin, &c.

Both sheets aft. The situation of a ship sailing right before the wind.

Bow grace. A frame of old rope or junk, laid out at the bows, stems, and side of ships, to prevent them from being injured by flakes of ice.

Bow lines. Lines made fast to the sides of the sails to haul them forward when upon a wind, which being hauled taut, enables the ship to come nearer to the wind.

To bowse. To pull upon any body with a tackle in order to remove it.

Bowsprit. A large mast or piece of timber which stands out from the bows of a ship.

Boxhauling. A particular method of veering a ship, when the swell of the sea renders tacking impracticable.

Boxing. An operation somewhat similar to Boxhauling. It is performed by laying the head sails aback, to receive the greatest force of the wind in a line perpendicular to their surfaces, in order to turn the ship's head into the line of her course, after she had inclined to windward of it.

Braces. The ropes by which the yards are turned about to form the sails to the wind.

To brace the yards. To move the yards, by means of the braces, to any direction required. *To brace about*—to brace the yards round for the contrary tack. *To brace sharp*—to brace the yards to a position in which they will make the smallest possible angle with the keel, for the ship to have head-way. *To Brace to*—to ease off the lee braces, and round in the weather braces, to assist the motion of the ship's head in tacking.

Brails. A name peculiar only to certain ropes belonging to the mizen, used to truss it up to the mast. But it is likewise applied to all the ropes which are employed in hauling up the bottoms, lower corners and skirts of the other great sails. *To brail up*—to haul up a sail by means of the brails, for the more ready furling it when necessary.

To break bulk. The act of beginning to unload a ship.

To break sheer. When a ship at anchor is forced, by the wind or current, from that position in which she keeps her anchor most free of herself and most firm in the ground, so as to endanger the tripping of her anchor, she is said to break her sheer.

Breaming. Burning off the filth from a ship's bottom.

Breast-fast. A rope employed to confine a ship sideways to a wharf or to some other ship.

To bring by the lee.—See to *broach to.*

To bring to. To check the course of a ship when she is advancing, by arranging the sails in such a manner that they shall counteract each other, and prevent her from either retreating or advancing. See *to lie to.*

To broach to. To incline suddenly to windward of the ship's course, so as to present her side to the wind, and endanger her oversetting. The difference between *broaching to* and *bringing by the lee* may be thus defined: Suppose a ship under great sail is steering south, having the wind at N. N. W. then west is the weather-side, and east the lee-side. If, by any accident, her head turns round to the westward, so that her sails are all taken a-back on the weather side, she is said to *broach to.* If, on the contrary, her head declines so far eastward as to lay her sails aback on that side which was the lee side, it is called *bringing by the lee.*

Broadside. A discharge of all the guns on one side of a ship both above and below.

Broken backed. The state of a ship which is so loosened in her frame as to drop at each end.

By the board. Over the ship's side.

By the head. The state of a ship when she is so unequally loaded as to draw more water forward than aft.

By the wind. The course of a ship as near as possible to the direction of the wind, which is generally within six points of it.

Bunt-lines. Ropes fastened to the foot rope of square sails to draw them up to the middle of the yards for furling.

Buoy. A floating conical cask, moored upon shoals to show where the danger is; also used at anchors to show where they lie, in case the cable breaks.

Cap. A strong thick block of wood, having two large holes through it, the one square, the other round; used to confine the two masts together.

Capsize. Overturn—the boat is capsized, that is, overset. Capsize the quoil of rope; that is, turn it over.

Capstan. An instrument by which the anchor is weighed out of the ground, used also for setting up the shrouds, and other work where a great purchase is required.

To Careen. To incline a ship on one side so low down, by shifting the cargo or stores on one side, that her bottom on the other side may be cleansed by breaming.

To carry away. To break—as a ship has carried away her bowsprit, that is, has broken it off.

Casting. The motion of falling off, so as to bring the direction of the wind on either side of the ship after it had blown sometime right a-head. It is particularly applied to a ship about to weigh anchor.

Cat-Heads. The timbers on ship's bows with sheaves in them, by which the anchor is hoisted after it has been hove up by the cable.

To cat the anchor is to hook the cat-block to the ring of the anchor, and haul it up close to the cat-head.

Cat's paw is a light air of wind perceived at a distance in a calm, sweeping the surface of the sea very lightly, and dying away before it reaches the ship.

Caulking is filling the seams of a ship with oakum.

Centre. This word is applied to that squadron of a fleet, in a line of battle, which occupies the middle of a line; and to that column (in the order of sailing) which is between the weather and lee columns.

Chains. A place built on the sides of the ship projecting out, and at which the shrouds are fastened, for the purpose of giving them greater angle than they could have if fastened to the ship's side, and of course giving them a greater power to secure the mast.

Chain plates, are plates of iron fastened to the ship's sides under the chains, and to these plates the dead eyes are fastened.

Chapelling. The act of turning a ship round in a light breeze of wind when she is close hauled, so that she will lie the same way she did before. This is usually occasioned by negligence in steering, or by a sudden change of wind.

Chase. A vessel pursued by some other. *Chaser*—the vessel pursuing.

Cheerly. A phrase implying heartily, quickly, cheerfully.

To claw off. The act of turning to windward from a lee shore, to escape shipwreck, &c.

Clear is variously applied:—The weather is said to be clear when it is fair and open, the sea-coast is clear when the navigation is not interrupted by rocks, &c. It is applied to cordage, cables, &c. when they are disentangled, so as to be ready for immediate service. In all these senses it is opposed to *foul.* *To clear the anchor* is to get the cable off the flukes, and to disencumber it of ropes, ready for dropping. *Clear hawse*—When the cables are directed to their anchors without lying athwart the stem. *To clear the hawse* is to untwist the cables when they are entangled by heaving either a cross, an elbow or a round turn.

Clenched. Made fast, as the cable is to the ring of the anchor.

Close hauled. That trim of the ship's sails, when she endeavours to make a progress in the nearest direction possible towards that point of the compass from which the wind blows.

To club haul. A method of tacking a ship when it is expected she will miss stays on a lee shore.

Clue-lines, are ropes which come down from the mast to the lower corners of the sails, and by which the corners or clues of the sails are hauled up.

Clue of a sail. The lower corners of square sails, but the aftermost only of stay sails, the other lower corner being called the tack.

To clue up. To haul up the clues of a sail to its yard by means of the clue lines.

Coasting. The act of making a progress along the sea-coast of any country.

To coil the cable. To lay it round in a ring, one turn over another.

To come home. The anchor is said to come home when it loosens from the ground by the effort of the cable, and approaches the place where the ship floated, at the length of her moorings.

Coming to, denotes the approach of a ship's head to the direction of the wind.

Course. The point of the compass upon which the ship sails. *Courses,* a ship's lower sails; as the fore-sail is the fore-course; the main-sail the main-course, &c.

The ship is under her courses; that is, has no sail set but the main-sail, fore-sail and mizen.
Coxswain. The person who steers the boat.
Crank. The ship is crank, that, is she has not a sufficient cargo or ballast to render her capable of bearing sail, without being exposed to the danger of oversetting.
Crow-foot, is a number of small lines spread from the fore parts of the tops, by means of the piece of wood through which they pass, and being hauled taut upon the stays, they prevent the foot of the topsails catching under the top rim; they are also used to suspend the awnings.
Cun. To direct. To cun a ship is to direct the man at helm how to steer.
To cut and run. To cut the cable and make sail instantly, without waiting to weigh anchor.
Davit. A long beam of timber, used as a crane, whereby to hoist the flukes of the anchor to the top of the bow, without injuring the planks of the ship's sides as it ascends. There is always a Davit of a smaller kind fixed to the long-boat to weigh the anchor by the buoy-rope.
To deaden a ship's way. To impede her progress through the water.
Dead eyes. Blocks of wood through which the laniards of the shrouds are reeved.
Dead lights. A kind of window shutter for the windows in the stern of a ship, used in very bad weather only.
Dead water. The eddy of water, which appears like whirlpools, closing in with the ship's stern as she sails on.
Dead-wind. The wind right against the ship, or blowing from the very point to which she wants to go.
Dismasted. The state of a ship that has lost her masts.
Dog-vane. A small vane with feathers and cork, and placed on the ship's quarter, for the men at cun and helm to see the course of wind by.
Dog-watch. The watches from four to six and from six to eight in the evening.
Doubling. The act of sailing round or passing beyond a cape or point of land.—Doubling upon—The act of inclosing any part of a hostile fleet between two fires, or of cannonading it on both sides.
Douce. To strike or haul down; as, douce the top-gallant sails, that is, lower them.
Down haul. The rope by which any sail is hauled down, as the jibb down-haul.
To dowse. To lower suddenly or slacken.
To drag the anchor. To trail it along the bottom after it is loosened from the ground.
To draw. When a sail is inflated by the wind, so as to advance the vessel in her course, the sail is said to *draw;* and so to *keep all drawing* is to inflate all the sails.
Drift. The angle which the line of a ship's motion makes with the nearest meridian, when she drives with her side to the wind and waves, and not governed by the power of the helm. It also implies the distance which the ship drives on that line.
Driver. A large sail set upon the mizen yards in light winds. Drive.—The ship drives, that is, her anchor comes through the ground.
Drop. Used sometimes to denote the depth of a sail; as the fore-top-sail drops twelve yards.
To drop anchor. Used synonimously with *to anchor.* To drop astern. The retrograde motion of a ship.
Dunnage. A quantity of loose wood, &c. laid at the bottom of a ship to keep the goods from being damaged.
Earings. Small ropes used to fasten the upper corners of sails to the yards.
To ease, to ease away, or *to ease off.* To slacken gradually; thus they say, *ease* the bowline, *ease* the sheet.
Ease the ship. The command given by the pilot to the steersman, to put the helm hard-a-lee, when the ship is expected to plunge her fore part deep in the water when close hauled.
To edge away. To decline gradually from the shore or from the line of the course which the ship formerly held in order to go more large.
To edge in with. To advance gradually towards the shore, or any other object.
Elbow in the Hawse. Is when a ship, being moored, has gone round upon the shifting of the tides twice the wrong way, so as to lay the cables one over the other: having gone once wrong, she makes a cross in the hawse, and going three times wrong, she makes a round turn.
End for end. A term used when a rope runs all out of a block, and is unreeved, or in coming to an anchor, if the stoppers are not well put on and the cable runs all out, it is said to have gone out end for end.
End on. When a ship advances to a shore, rock, &c. without an apparent possibility of preventing her, she is said to go *end on* for the shore, &c.
Engagement. Action or fight.
Ensign. The flag worn at the stern of a ship.
Entering port. A large port in the side of three deckers leading into the middle deck, to save the trouble of going up the ship's side to get on board.

Even keel. When the keel is parallel with the horizon, a ship is said to be upon an *even keel.*
Fair. A general term for the disposition of the wind, when favourable to a ship's course.
Fair-way. The channel of a narrow bay, river, or haven, in which ships usually advance in their passage up and down.
Fack, or *Fake.* One circle of any rope or cable quoiled.
Fag end. The end of any rope which is become untwisted by frequent use; to prevent which the ends of ropes are wound round with pieces of twine, which operation is called *whipping.*
To fall a-board of. To strike or encounter another ship when one or both are in motion. *To fall astern*—The motion of a ship with her stern foremost. *To fall calm.* To become in a state of rest by a total cessation of the wind. *To fall down.* To sail or be towed down a river nearer towards its mouth.
Falling off denotes the motion of the ship's head from the direction of the wind. It is used in opposition to *coming to.*
Fall not off, or nothing off. The command of the steersman to keep the ship near the wind.
Fathom. A measure of six feet.
To fetch away. To be shaken or agitated from one side to another so as to loosen any thing which before was fixed.
Fid. A square bar of wood or iron, with shoulders at one end, used to support the weight of the topmast, when erected at the head of a lower-mast.
Fid for splicing. A large piece of wood of a conical figure; used to extend the strands and layers of cables in splicing.
To fill. To brace the sails so as to receive the wind in them, and advance the ship in her course, after they had been either shivering or braced a-back.
Fish. A large piece of wood. *Fish the mast;* apply a large piece of wood to it to strengthen it.
Fish-hook. A large hook by which the anchor is received and brought to the cat-head; and the tackle which is used for this purpose is called the fish-tackle.
To fish the anchor. To draw up the flukes of the anchor towards the top of the bow, in order to stow it, after having been catted.
Flag. A general name for colours worn and used by ships of war.
Flat aft. The situation of the sails when their surfaces are pressed aft against the mast by the force of the wind.
To flat in. To draw in the aftermost lower corner, or clue, of a sail towards the middle of the ship, to give the sail a greater power to turn the vessel. *To flat in forward.* To draw in the fore sheet, jibb-sheet, and fore-staysail sheet, towards the middle of the ship.
Flaw. A sudden breeze or gust of wind.
Floating. The state of being buoyed up by the water from the ground.
Flood-tide. The state of a tide when it flows or rises.
Flowing sheets. The position of the sheets of the principal sails when they are loosened from the wind so as to receive it into their cavities more nearly perpendicular than when close-hauled, but more obliquely than when the ship sails before the wind. A ship going two or three points large has *flowing sheets.*
Fore. That part of a ship's frame and machinery that lies near the stem. *Fore and aft.* Throughout the whole ship's length. Lengthways of the ship.
Fore-reach. To shoot a-head, or go past another vessel.
To force over. To force a ship violently over a shoal by a great quantity of sail.
Forward. Towards the fore part of a ship.
Foul. Is used in opposition both to clear and fair. As opposed to clear we say, foul weather, foul bottom, foul ground, foul anchor, foul hawse. As opposed to fair, we say foul wind.
To Founder. To sink at sea by filling with water.
To free. Pumping is said to free the ship when it discharges more water than leaks into her.
To freshen. When a gale increases it is said to freshen. *To freshen the Hawse.* Veering out or heaving in a little cable to let another part of it endure the stress of the hawseholes. It is also applied to the act of renewing the service round the cable at the hawseholes.
Freshen the ballast. Divide or separate it.
Fresh away. When a ship increases her velocity, she is said to get fresh way.
Full. The situation of the sails, when they are kept distended by the wind.
Full and by. The situation of a ship, with regard to the wind, when close hauled and sailing, so as to steer neither too nigh the direction, nor to deviate to leeward.
To furl. To wrap or to roll a sail close up to the yard or stay to which it belongs, and winding a cord around it, to keep it fast.
Gage of the ship. Her depth of water, or what water she draws.

To gain the wind. To arrive on the weather side, or to windward of some ship or fleet in sight, when both are sailing as near the wind as possible.
Gammon the bowsprit. Secure it by turns of a strong rope passed round it, and into the cat-water, to prevent it from having too much motion.
Gangway. That part of a ship's side both within and without, by which persons enter and depart.
Garboard streak. The first range or streak of planks laid in a ship's bottom next the keel.
Gasket. The rope which is passed round the sail to bind it to the yard when it is furled.
To gather. A ship is said to gather on another as she comes nearer to her.
Gimbleting. The action of turning the anchor round by the stock, so that the motion of the stock appears similar to that of the handle of a gimblet, when employed to turn the wire.
Girt. The ship is girt with her cables when she is too tight moored.
To give chase to. To pursue a ship or fleet.
Goose-wings of a sail. The clues or lower corners of a ship's mainsail or foresail, when the middle part is furled or tied up to the yard.
Grappling-iron. A thing in the nature of an anchor, with four or six flukes to it.
Greave. To burn off the filth from a ship's bottom.
Gripe of a ship. That thin part of her which is under the counter; and to which the sternpost joins. The ship gripes, that is, turns her head too much to the wind.
Grounding. The laying the ship a-shore, in order to repair her. It is also applied to running aground accidentally.
Ground tackle. Every thing belonging to a ship's anchors, and which are necessary for anchoring or mooring; such as cables, hawsers, tow-lines, warps, buoy-ropes, &c.
Ground tier. That is, the tier of water casks which is lowest in the hold, and is among the shingle ballast.
Growing. Stretching out; applied to the direction of the cable from the ship towards the anchors: as, the cable grows on the starboard bow.
Grommet. A piece of rope laid into a circular form, and used for large boat's oars instead of rowlocks, and also for many other purposes.
Gunnel. The upper edge of a ship's side.
Gun-room. A division of the lower deck abaft, enclosed with network, for the use of the gunner and his stores.
Gybing. The act of shifting any boom-sail from one side of the mast to the other.
Hail. To call to another ship.
Haliards. The ropes by which the sails are hoisted, as the top-sail haliards, or jibb haliards, &c.
Handing. The same as furling.
Hard a-weather. Put the tiller quite up to windward.
Haul. Pull.
To haul the wind. To direct the ship's course nearer to the point from which the wind blows.
Hawse-holes. The holes in the bows of the ship through which the cables pass.—*Freshen hawse*, veer out more cable. *Clap a service in the hawse;* put somewhat round the cable at the hawse-hole to prevent its chafing. To *clear hawse*, is to untwist the cables where a ship is moored, and has got a foul hawse. *Athwart hawse*, is to be across or before another ship's head.
Hawser. A small kind of cable.
Head fast. A rope employed to confine the head of a ship to a wharf or to some other ship. *Headmost.* The situation of any ship or ships which are the most advanced in a fleet. *Head sails.* All the sails which belong to the foremast and bowsprit.
Head-sea. When the waves meet the head of a ship in her course, they are called a head-sea. It is likewise applied to a single wave coming in that direction.
Head to-wind. The situation of a ship when her head is turned to the point from which the wind blows, as it must when tacking.
Head-way. The motion of advancing, used in opposition to stern-way.
To Heave. To turn about a capstan, or other machine of the like kind, by means of bars, handspikes &c. To *Heave a-head*, to advance the ship by heaving-in the cable or other rope fastened to an anchor at some distance before her. To *Heave a-peek*, to heave-in the cable, till the anchor is a-peek.
To Heave a-stern, to move a ship backwards by an operation similar to that of heaving a-head. To *Heave down*, to careen. To *Heave in the cable*, to draw the cable into the ship, by turning the capstan. To *Heave in stays*, to bring a ship's head to the wind, by a management of the sails and rudder, in order to get on the other tack. To *Heave out*, to unfurl or loose a sail; more particularly applied to the staysails; thus we say, loose the topsails and heave out the staysails. To *Heave short*, to draw so much of the cable into the ship, as that she will be almost perpendicularly over her anchor. To *Heave tight or taut*, to turn the capstan round till the rope or cable becomes straightened, To *Heave the capstan*, to turn it round. To *Heave the*

lead, to throw the lead overboard, in order to find the depth of water. To *Heave the log*, to throw the log overboard, in order to calculate the velocity of the ship's way. *Heave the capstan*, that is, turn it round with the bars. *Heave handsomely*, heave gently or leisurely. *Heave hearty*, heave strong and quick.

Heave of the sea, is the power that the swell of the sea has upon a ship in driving her out, or faster on, in her course, and for which allowance is made in the day's work.

Heel, or incline. She heels to port, that is, inclines or lays down upon her larboard or left side.

Helm. The instrument by which the ship is steered, and includes both the wheel and the tiller, as one general term. *Helm's a-lee*, that is, the tiller is quite down to leeward

High and dry. The situation of a ship when so far run aground as to be seen dry upon the strand.

Hitch. To make fast.

Hoist. To haul, sway, or lift up.

Hold, is the space between the lower deck and the bottom of the ship, where her stores, &c. lie.

To stow the hold, is to place the things in it.

To hold its own, is applied to the relative situation of two ships when neither advances upon the other; each is then said to hold its own. It is likewise said of a ship which, by means of contrary winds, cannot make a progress towards her destined port, but which, however, keeps nearly the distance she had already run.

Home, implies the proper situation of any object; as, to *haul home* the topsail sheets, is to extend the bottom of the topsail to the lower yard, by means of the sheets. In stowing a hold, a cask, &c. is said *to be home*, when it lies close to some other object.

Hulk. A ship without masts or rigging; also a vessel to remove masts into or out of ships by means of sheers, from whence they are called *sheer hulks*.

Horse. A rope reaching from the middle of a yard to its arms or extremities, for the men to stand on when they are loosing, reefing, or furling a sail.

Hull of the ship, the body of it. *To lay a hull*, is to lay to with only a small sail in a gale of wind. *To hull a vessel*, is to fire a shot into any part of her hull.

Hull down, is when a ship is so far off that you can only see her masts. *To hull a ship*—to fire cannon balls into her hull within the point-blank range. *Hull to*—the situation of a ship when she lies with all her sails furled: as in *trying*.

In stays. See to *heave in stays*.

Jamming. The act of enclosing any object between two bodies so as to render it immoveable.

Jeer blocks. The blocks through which jeers are reeved.

Jeers. The ropes by which the lower yards are suspended.

Jibb. The foremost sail of a ship, set upon a boom which runs out upon the bowsprit.

Jibb-boom. A spar that runs out upon the bowsprit.

Jolly-boat. A small boat.

Junk. Old cable, or old rope.

Jury-mast. A temporary or occasional mast erected in a ship in the place of one which has been carried away by accident, &c.

Kedge. A small anchor with an iron stock.

Keel. The principal piece of timber in a ship, which is usually first laid on the blocks in building.

Keel-haul. To drag a person backwards and forwards under a ship's keel for certain offences.

Keckled. Any part of a cable, covered over with old ropes, to prevent its surface from rubbing against the ship's bow or fore-foot.

To keep away. To alter the ship's course to one rather more large, for a little time, to avoid some ship, danger, &c. *Keep away* is likewise said to the steersman who is apt to go to windward of the ship's course. *To keep full*—To keep the sails distended by the wind. *To Keep hold of the land*—to steer near to or in sight of the land. *To Keep off*—to sail off or keep at a distance from the shore. *To Keep the land aboard*—the same as to *keep hold of the land*. *To Keep the Luff*—to continue close to the wind. *To keep the wind*—the same as to *keep the luff*.

Kelson. A piece of timber forming the interior of the keel; being laid on the middle of the floor timbers immediately over the keel, and serving to unite the former to the latter.

Kentledge. Pigs of iron for ballast, laid upon the floor, near the kelson, fore and aft.

Kenk. A sort of twist or turn in a cable or rope.

Knippers. A large kind of plated rope, which being twisted round the messenger and cable in weighing, bind them together.

Knot. A division of the log-line, answering in the calculation of the ship's velocity, to one mile.

To Labour. To roll or pitch heavily in a turbulent sea.

Laden in Bulk. Freighted with a cargo not packed, but lying loose, as corn, salt, &c.

Laid up. The situation of a ship when moored in a harbour, for want of employ.

Land fall. The first land discovered after a sea voyage. Thus a *good land fall* implies the land expected or desired; a *bad land fall* the reverse.

Land-locked. The situation of a ship surrounded with land, so as to exclude the prospect of the sea, unless over some intervening land.

Laniards of the shrouds, are the small ropes at the ends of them, by which they are hove taut or tight.

Larboard. The left side of a ship, looking towards the head. *Larboard Tack*—the situation of a ship when sailing with the wind blowing upon her larboard side.

Lash. To bind.

Launch-ho, signifies high enough, or lower.

Laying the land. A ship which increases her distance from the coast, as to make it appear lower and smaller, is said to *lay the land.*

Leading-wind. A fair wind for a ship's course.

Leak. A chink or breach in the sides or bottom of a ship, through which the water enters into the hull.

Lee. That part of the hemisphere to which the wind is directed, to distinguish it from the other part which is called to windward. *Lee Gage*—a ship or fleet to leeward of another is said to have the lee-gage. *Lee-Lurches*—the sudden and violent rolls which a ship often takes to leeward, in a high sea, particularly when a large wave strikes her on the weather-side. *Lee-Quarter*—that quarter of a ship which is on the lee side. *Lee-Shore*—that shore upon which the wind blows. *Lee-side*—that half of a ship lengthwise, which lies between a line drawn through the middle of her length and the side which is farthest from the point of wind. *To Leeward*—towards that part of the horizon to which the wind blows. *Leeward-Ship*—a ship that falls much to leeward of her course, when sailing close hauled. *Leeward Tide*—a tide that sets to leeward.

Lee-Way. The lateral movement of a ship to leeward of her course; or the angle which the line of her way makes with a line in the direction of her keel.

To Lie along. To be pressed down sideways by a weight of sail in a fresh wind.

Leeches. The borders or edges of a sail.

To Lie to. To retard a ship in her course, by arranging the sails in such a manner as to counteract each other with nearly an equal effort, and render the ship almost immoveable with respect to her progressive motion or head way.

Lifts. The ropes which come to the ends of the yards from the mast-heads, and by which they are suspended when lowered down.

Limbers, or *Limber-holes.* Square holes cut through the lower part of a ship's floor timbers, very near the keel; forming a channel for water, and communicating with the pump-well throughout the whole length of the floor.

List. Incline. *The ship has a list to port,* that is, she heels to the larboard.

Log, and *Log line,* by which the ship's path is measured, and her rate of going ascertained.

Log-board, on which is marked the transactions of the ship, and from thence it is copied into the log-book every 24 hours.

A Long Sea. A uniform motion of long waves.

Look out. A watchful attention to some important object or event that is expected to arise. Thus persons on board of a ship are occasionally stationed to *look out* for signals, other ships, for land, &c.

To Loose. To unfurl or cast loose any sail.

To Lower. To ease down gradually.

Luff. The order to the steersman to put the helm towards the lee side of the ship in order to sail nearer to the wind.

To make a board. To run a certain distance upon one tack, in beating to windward. *To make foul water*—to muddy the water, by running in shallow places, so that the ship's keel disturbs the mud at the bottom. *To make sail*—to increase the quantity of sail already set, either by unreefing or by setting others. *To make stern way*—to retreat or move with the stern foremost. *To make the land*—To discover it from afar. *To make water*—to leak.

To man the yard, &c. To place men on the yard, in the tops, down the ladder, &c. to execute any necessary duties.

Mast. The upright timber or trees on which the yards and sails are set.

Masted. Having all her masts complete.

Mend the service. Put on more service.

Messenger. A small kind of cable, which being brought to the capstan, and the cable by which the ship rides made fast to it, it purchases the anchor.

To middle a rope. To double it into two equal parts.

Midships. See *Amidships.*

To miss stays. A ship is said to *miss stays* when her head will not fly up into the direction of the wind, in order to get her on the other tack.

Mizen mast. The mast which stands abaft, and from which its rigging and sails are named; as of the sails, mizen, mizen-top-sail, &c. and so also are the other sails, &c. named from the other masts.

Moor, is to secure a ship with two anchors. *Mooring*—securing a ship in a particular station by chains or cables, which are either fastened to an adjacent shore or to anchors at the bottom. *Mooring service*—when a ship is moored, and rides at one cable's length, the mooring service is that which is at the first splice.

Mouse. A kind of ball or knob, wrought upon the collar of the stays.

Muster. To assemble.

Narrows. A small passage between two lands.

Neape Tides. The tides in the first and last quarter of the moon, and are not either so high, so low, or so rapid as spring tides. A ship is said *to be beneaped* when she has not water enough to take her off the ground, or over the bar, &c.

Near, or nonear. An order to the steersman not to keep the ship so close to the wind.

Nippers. Certain pieces of cordage used to fasten the messenger to the cable in heaving up the anchor.

Nothing off. A term used by the man at the cun to the steersman, directing him not to go from the wind.

Nun buoy. The kind of buoys used by ships of war.

Oakum. Old rope untwisted and pulled open.

Off and on. When a ship is beating to windward, so that by one board she approaches towards the shore, and by the other stands out to sea, she is said to stand *off and on* shore.

Offing. To seaward from the land. *A ship is in the offing*, that is, she is to seaward, at a distance from the land. *She stands for the offing*, that is, towards the sea.

Offward. From the shore, as when a ship lies aground and leans towards the sea, she is said to heel *offward.*

On board. Within the ship, as, he is come on board.

On the beam. Any distance from the ship on a line with the beams, or at right angles with the keel. See *Bearing.*

On the bow. An arch of the horizon, comprehending about four points of the compass on each side of that point to which the ship's head is directed. Thus, they say, the ship in sight bears three points on the starboard bow; that is, three points towards the right hand, from that part of the horizon which is right a-head. See *Bearing.*

On the quarter. An arch of the horizon, comprehending about four points of the compass on each side of that point to which the ship's stern is directed. See *On the bow.*

Open. The situation of a place exposed to the wind and sea. It is also expressed of any distant object to which the sight or passage is not intercepted.

Open Hawse. When the cables of a ship at her moorings lead straight to their respective anchors, without crossing, she is said to ride with an *open hawse.*

Orlop. The deck on which the cables are stowed.

Over-board. Out of the ship; as, he fell over-board, meaning he fell out of, or from the ship.

Overgrown Sea, is expressed of the ocean when the surges and billows rise extremely high.

Overhaul. To clear away and disentangle any rope; also to come up with the chase; as *we overhaul her*, that is, we gain ground of her.

Over-Rake. When a ship at anchor is exposed to a head-sea, the waves of which break in upon her, the waves are said to *over-rake* her.

Over-set. A ship is *over-set* when her keel turns upwards.

Out-of-trim. The state of the ship when she is not properly balanced for the purposes of navigation.

Parcel a rope. Is to put a quantity of old canvass upon it before the service is put on. *Parcel a seam*—is to lay a narrow piece of canvass over it after it is caulked, before it it is payed.

Parliament heel. The situation of a ship when she is made to stoop a little to one side, so as to clean the upper part of her bottom on the other side. See *Boot-topping.*

Parting. Being driven from the anchors, by the breaking of the cable.

Pawl. A short bar of wood or iron fixed close to the capstan or windlass of a ship, to prevent those engines from rolling back, or giving way, when they are charged with any great effort.

To Pawl the capstan. To fix the pawls so as to prevent the capstan from recoiling, during any pause of heaving.

To pay. To daub or cover the surface of any body with pitch, tar, &c. in order to prevent it from the injuries of the weather.

To pay away or pay out. To slacken a cable or other rope, so as to let it run out for some particular purpose.

To pay off. To move a ship's head to leeward.
To peek the mizen. To put up the mizen yard perpendicular by the mast.
Peck. To ride a stay peck, is when the cable and the fore-stay form a line. *To ride a short peck*, is when the cable is so much in as to destroy the line formed by the stay-peck. *To ride with the yards a peck*, is to have them topped up by contrary lifts, so as to represent St. Andrew's cross.
Pendant. The long narrow flag worn at the mast-head by all ships of the navy. *Brace Pendants*—are those ropes which secure the brace-blocks to the yard arms, and are in general double, in case of one being shot away, the other may secure the yards in its proper position.
Broad Pendant. A kind of flag terminating in a point used to distinguish the chief of a squadron.
Pitching. The movement of a ship, by which she plunges her head and after part alternately into the hollow of the sea.
Point-blank. The direction of a gun when levelled horizontally.
Points. A number of plated ropes made fast to the sails for the purpose of reefing.
Poop. The highest and aftermost deck of a ship.
Pooping. The shock of a high and heavy sea upon the stern or quarter of a ship, when she scuds before the wind in a tempest.
Port. A name given on some occasions to the larboard side of the ship; as, the ship heels to port, top the yards to port, &c.—also, a harbour or haven.
Ports. The holes in the ship's sides from which the guns are fired.
Port the helm! The order to put the helm over to the larboard side.
Port-last. The gunnel.
Press of Sail. All the sail that a ship can set or carry.
Preventer. An additional rope employed at times to support any other, when the latter suffers an unusual strain, particularly when blowing fresh, or in a gale of wind.
Pudding and Dolphin. A large and lesser pad made of ropes, and put round the mast under the lower yards.
Purchase. Any sort of mechanical power employed in raising or moving heavy bodies.
Quarters. The respective stations of the officers and people in time of action. *Quartering*, distributing the men into different places. *Quarter-bill*, the list of the ship's company, with their stations for action noticed.
Quarter-wind, is when the wind blows in from that part of the horizon situated on the quarter of the ship. See *On the quarter*.
Quoil, is a rope or cable laid up round, one fake over another.
To Raise. To elevate any distant object at sea by approaching it; thus, *to raise the land* is used in opposition to *lay the land.*
To Rake. To cannonade a ship at the stern or head, so that the balls scour the whole length of the decks.
Range of Cable. A sufficient length of cable drawn upon deck before the anchor is cast loose, to admit of its sinking to the bottom without any check.
Ratlines. The small ropes fastened to the shrouds, by which the men go aloft.
Reach. The distance between any two points on the banks of a river, wherein the current flows in an uninterrupted course.
Ready about! A command of the boatswain to the crew, and implies that all the hands are to be attentive and at their stations for tacking.
Rear. The last division of a squadron, or the last squadron of a fleet. It is applied likewise to the last ship of a line, squadron, or division.
Reef. Part of a sail from one row of eyelet-holes to another. It is applied likewise to a chain of rocks lying near the surface of the water.
Reefing. The operation of reducing a sail by taking in one or more of the reefs.
To Reeve. To pass the end of a rope through any hole, as the channel of a block, the cavity of a thimble, &c.
Rendering. The giving way or yielding to the efforts of some mechanical power. It is used in opposition to jambing or sticking.
Ribs of a ship. A figurative expression for the timbers.
Ride at anchor, is when a ship is held by her anchors, and is not driven by wind or tide. To *ride athwart*, is to ride with the ship's side to the tide. To *ride hawse fallen*, is when the water breaks into the hawse in a rough sea.
Rigging. A general name given to all the ropes employed to support the masts, to extend or reduce the sails, or to arrange them to the disposition of the wind.
Righting. Restoring a ship to an upright position, either after she has been laid on a careen, or after she has been pressed down on her side by the wind.
To right the helm, is to bring it into midships, after it has been pushed either to starboard or larboard.
Rigging out a boom. The running out a pole at the end of a yard to extend the foot of a sail.
To rig the capstern. To fix the bars in their respective holes.

Road. A place near the land where ships may anchor, but which is not sheltered.
Robands, or *Ropebands.* Short flat pieces of plaited rope, having an eye worked at one end; they are used in pairs to tie the upper edges of the square sails to their respective yards.
Rolling. The motion by which a ship rocks from side to side like a cradle.
Rough-Tree. A name applied to any mast, yard, or boom, placed in merchant ships, as a rail or fence above the vessel's side, from the quarter-deck to the fore-castle.
Rounding-in. The pulling upon any rope which passes through one or more blocks in a direction nearly horizontal; as, *round in* the weather-braces.
Rounding. Old ropes fastened on the cable, near the anchor, to keep it from chafing.
Round-turn. The situation of the two cables of a ship when moored, after they have been several times crossed by the swinging of the ship.
Rounding-up. Similar to *rounding-in*, except that is applied to ropes and blocks which act in a perpendicular direction.
To Row. To move a boat with oars.
Rowsing. Pulling up a cable or rope without the assi tance of tackles.
Rudder. The machine by which the ship is steered.
Rullock. The niche in a boat's side, in which the oars are used.
Run. The aftermost part of a ship's bottom, where it grows extremely narrow as the stern approaches the stern-post. Run is also the distance sailed by a ship; and is likewise used by sailors to imply the agreement to work a single passage from one place to another.
To run out a warp. To carry the end of a rope out from a ship, in a boat, and fasten it to some distant object, so that by it the ship may be removed by pulling on it.
To sag to leeward. To make considerable lee-way.
Sailing-trim is expressed of a ship when in the best state for sailing.
She sands or sends. When the ship's head or stern falls deep in the trough of the sea.
Scanting. The variation of the wind, by which it becomes unfavourable to a ship's making great progress, as it deviates from being large, and obliges the vessel to steer close hauled, or nearly so.
Scud. To go right before the wind; and going in this direction without any sail set is called *spooning.*
Scuttling. Cutting large holes through the bottom or sides of a ship, either to sink her, or to unlade her expeditiously when stranded.
Sea. A large wave is so called. Thus, they say a *heavy sea.* It implies likewise the agitation of the ocean, as, a *great sea.* It expresses the direction of the waves, as, a *head sea.* A *long sea* means a uniform and steady motion of long and extensive waves; a *short sea*, on the contrary, is when they run irregularly, broken, and interrupted.
Sea-boat. A vessel that bears the sea firmly, without straining her masts, &c.
Sea-clothes. Jackets, trowsers, &c.
Sea-mark. A point or object on shore conspicuously seen at sea.
Sea-room. A sufficient distance from the coast or any dangerous rocks, &c. so that a ship may perform all nautical operations without danger of shipwreck.
Seize. To bind or make fast.
Serve. To wind something about a rope to prevent it from chafing or fretting. The service is the thing so wound about the rope.
Setting. The act of observing the situation of any distant object by the compass.
To set sail. To unfurl and expand the sails to the wind, in order to give motion to the ship.
To set up. To increase the tension of the shrouds, back-stays, &c. by tackles, laniards, &c.
Settle. To lower; as, *settle the topsail haliards*, lower them.
To settle the land. To lower in appearance. It is synonymous with *to lay the land.*
Shank. The beam or shaft of an anchor.
Shank-painter. The rope by which the shank of the anchor is held up to the ship's side; is also made fast to a piece of iron chain, in which the shank of the anchor lodges.
To shape a course. To direct or appoint the track of a ship, in order to prosecute a voyage.
Sheer. The sheer of the ship is the curve that is between the head and the stern upon her side. *The ship sheers about*, that is, she goes in and out.
To sheer off. To remove to a greater distance.
Sheers, are spars lashed together and raised up for the purpose of getting out or in a mast.
Sheet. A rope fastened to one or both of the lower corners of a sail, in order to extend and retain it in a particular situation. When a ship sails with a side wind, the lower corner of the main and fore-sails are fastened by a tack and a sheet, the former being to windward, and the latter to leeward; the tack is, however, only disused with a stern wind, whereas the sail is never spread without the assistance of one or both of the sheets; the stay-sails and studden-sails have only one tack and one sheet each, the stay-sail tacks are fastened forward, and the sheets drawn aft, but the

studden-sail tacks draw the outer corner of the sail to the extremity of the boom, while the sheet is employed to extend the inner corner.

To sheet home. To haul the sheets of a sail home to the block on the yard-arm.

To shift the helm. To alter its position from right to left, or from left to right.

To ship. To take any person, goods, or thing on board. It also implies to fix any thing in its proper place, as, to *ship the oars*, to fix them in their rullocks.

Ship-shape. In a seaman like manner ; as, that mast is not rigged ship-shape ; put her about ship-shape, &c.

Shivering. The state of a sail when fluttering in the wind.

Shoal. Shallow.

Shoe the anchor. A small block of wood, convex on the back, and having a hole sufficiently large to contain the point of the anchor-fluke on the fore side ; it is used to prevent the anchor from tearing the planks on the ship's bow, when ascending or descending.

To shoot a-head. To advance forward.

Shore. A general name for the sea coast of any country.

To shorten sail. Used in opposition to *make sail.*

Shrouds. A range of large ropes extended from the mast heads to the right and left sides of a ship, to support the masts, and enable them to carry sail.

Sinnett. A small plaited rope, made from rope-yarns.

Slack-water. The interval between the flux and reflux of the tide, when no motion is perceptible in the water.

Slatch, is applied to the period of a transitory breeze.

To slip the cable. To let it run quite out when there is not time to weigh the anchor.

To slue. To turn any cylindrical piece of timber about its axis without removing it. Thus, to *slue a mast*, or *boom*, is to turn it in its cap or boom iron. Also to turn any package or cask round.

Sound. To try the depth of water.

Sounding-line. A line to sound with, which is marked in the following manner:—Black leather at 2 and 3 fathoms, white at 5, red at 7, black at 10, white at 13, (some seamen use black at 10 and 13) white at 15 as at 5, red at 17 as at 7, two knots at 10 fathoms, and an additional knot at every ten fathoms, with a single knot midway between each 10 fathoms, to mark the line at every five fathoms.

To spell the Mizen. To let go the sheet and peek it up.

To spill. To discharge the wind out of the cavity or belly of a sail, when it is drawn up in the brails, in order to furl or reef it.

Spilling lines, are ropes contrived to keep the sails from being blown away, when they are clewed up in blowing weather.

Splice. To make two ends of ropes fast together by untwisting them, and then putting the strands of one piece with the strands of the other.

Split. The state of a sail rent by the violence of the wind.

Spoon-drift. A sort of showery sprinkling of the sea water, swept from the surface of the waves in a tempest, and flying like a vapour before the wind.

Spray. The sprinkling of a sea, driven occasionally from the top of a wave, and not continual as a spoon-drift.

To spring a mast, yard, &c. To crack a mast, yard, &c. by means of straining in blowing weather, so that it is rendered unsafe for use. *To spring a leak.* When a leak first commences, a ship is said to *spring a leak.* *To spring the luff.* A ship is said to *spring her luff*, when she yields to the effort of the helm, by sailing nearer to the wind than before.

Spring-stays, are rather smaller than the stays, and placed above them, and intended to answer the purpose of the stay, if it should be shot away, &c.

Spring-tides, are the tides at new and full moon, which flow highest and ebb lowest.

Spurling Line, is a line that goes round a small barrel abaft the barrel of the wheel, and coming to the front beam of the poop deck, moves the tell-tale with the turning of the wheel, and keeps it always in such position, as to show the position of the tiller.

Spur-shoes, are large pieces of timber which come abaft the pump-well.

Squall. A sudden violent blast of wind.

Square. This term is applied to yards that are very long, as *taunt* is to high masts.

To square the yards. To brace the yards so as to hang at right angles with the keel.

To stand on. To continue advancing. *To stand in.* To advance towards the shore. *To stand off.* To recede from the shore.

Starboard. The right hand side of the ship when looking forward. *Starboard-tack.* A ship is said to be on the *starboard tack* when sailing with the wind blowing upon her starboard side.

Starboard the helm! An order to push the helm to the starboard side.

To stay a ship. To arrange the sails and move the rudder so as to bring the ship's head to the direction of the wind, in order to get her on the other tack.

Stays. Large ropes coming from the mast heads down before the masts, to prevent them from springing, when the ship is sending deep.
Steady! The order to the helmsman to keep the ship in the direction she is going at that instant.
Steering. The art of directing the ship's way by the movement of the helm.
Steerage-way. Such degree of progressive motion of a ship as will give effect to the motion of the helm.
Stem. A circular piece of timber, into which the two sides of a ship are united at the fore end; the lower end is scarfed to the keel, and the bowsprit rests on the upper end.
To stem the tide. When a ship is sailing against the tide at such a rate as enables her to overcome its power, she is said to *stem the tide.*
Steeve. Turning up. The bowsprit steeves too much, that is, it is too upright.
Sternfast. A rope confining a ship by her stern to any other ship or wharf.
Sternmost. The furthest astern, opposed to *headmost.*
Sternway. The motion by which a ship falls back with her stern foremost.
Stiff. The condition of a ship when she will carry a great quantity of sail without hazard of oversetting. It is used in opposition to *crank.*
Stoppers. Large kind of ropes, which, being fastened to the cable in different places abaft the bitts, are an additional security to the ship at anchor.
To stow. To arrange and dispose a ship's cargo.
Strand. One of the twists or divisions of which a rope is composed. It also implies the sea beach.
Stranded. This term, speaking of a cable or rope, signifies that one of its strands is broken: applied to a vessel, it means that she has run aground and is lost.
To stream the buoy. To let it fall from the ship's side into the water, previously to casting anchor.
Stretch out. A term used to men in a boat when they should pull strong.
To strike. To lower or let down any thing. Used emphatically to denote the lowering of colours in token of surrender to a victorious enemy.
To strike sounding. To touch ground when endeavouring to find the depth of water.
Sued, or *Sewed.* When a ship is on shore and the water leaves her, she is said to be sued; if the water leaves her two feet, she sues, or is sued two feet.
Surf. The swell of the sea that breaks upon shore or on any rock.
To surge the capstern. To slacken the rope heaved round upon it.
Sway away. Hoist.
Swell. The fluctuating motion of the sea either during or after a storm.
Sweeping. The act of dragging the bight or loose part of a rope along the surface of the ground, in a harbour or road, in order to drag up something lost.
Swinging. The act of a ship's turning round her anchor at the change of wind or tide.
To tack. To turn a ship about from one tack to another, by bringing her head to the wind.
Taffarel. The uppermost part of a ship's stern.
Taking in. The act of furling the sails. Used in opposition to *setting.*
Taking a-back. See *a-back.*
Tamkins, or *Tomkins.* The bung, or piece of wood, by which the mouth of a cannon is filled to keep out wet.
Tarpaulin. A cloth of canvass covered with tar or some other composition, so as to make it water proof.
Taught. Improperly though very generally used for *tight.*
Taunt. High or tall. Particularly applied to masts of extraordinary length.
Tell-tale. An instrument which traverses upon an index in the front of the poop-deck, to show the position of the tiller.
Tending. The turning or swinging of a ship round her anchor in a tide-way at the beginning of ebb and flood.
Thwart. See *a-thwart.* *Thwart ships.* See *a-thwart ships.*
Thus. An order to the helmsman to keep the ship in her present situation, when sailing with a scant wind.
To tide. To work in or out of a river, harbour, or channel, by favour of the tide, and anchoring whenever it becomes adverse.
Tide it up. To go with the tide against the wind.
Tide-way. That part of the river in which the tide ebbs and flows strongly.
Tier. A row; as a tier of guns, a tier of casks, a tier of ships, &c. *Tier of a cable.* A range of the fakes or windings of a cable which are laid within one another, in a horizontal position. *Cable Tier*—the space in the midst of a cable when it is coiled; also the place in which it is coiled.
Tiller. A large piece of wood or beam, put into the head of the rudder, and by means of which the rudder is moved.
Topping. Pulling one of the ends of a yard higher than the other.

Tort or Taut, signifies tight.
To Tow. To draw a ship in the water by a rope, fixed to a boat or other ship which is rowing or sailing on.
Tow-line. A small hawser, or rope, used to remove a ship from one part of a harbour to another.
Transoms. Certain beams or timbers extended across the sternpost of a ship to fortify her after part, and to give it the figure most suitable to the service for which she is calculated.
Traverse. To go backwards and forwards.
Treenails or Trunnals. Long wooden pins employed to connect the planks of the ship's side and bottom to the corresponding timbers.
Trey-sail. A small sail used by cutters and brigs in blowing weather.
Trice, trice up. To haul up and fasten.
Trim. The state or disposition by which a ship is best calculated for the purposes of navigation. *To trim the hold*—to arrange the cargo regularly. *To trim the sails*—to dispose the sails in the best arrangement for the course which a ship is steering.
To trip the anchor. To loosen the anchor from the ground, either by design or accident.
Trough of the Sea. The hollow between two waves.
Truck. A round piece of wood put upon the top of flag-staves, with sheaves on each side for the haliards of the flags to reeve in.
Turning to windward. That operation in sailing, whereby a ship endeavours to advance against the wind.
To Unballast. To discharge the ballast out of a ship.
To Unbend. To take the sails off from their yards and stays. To cast loose the anchor from the cable. To untie two ropes.
To Unbit. To remove the turns of a cable from off the bits.
Under foot, is expressed of an anchor that is directly under the ship.
Under sail, or under way. When a ship is sailing she is said to be *under way*.
Under the lee of the shore, is to be close under the shore which lies to windward of the ship.
Unfurl. Cast loose the gasket of the sail.
To Unmoor. To reduce a ship to the state of riding at single anchor, after she has been moored.
To Unreeve. To draw a rope from out of a block, timber, &c.
To Unrig. To deprive the ship of her rigging.
Uvrou. The piece of wood by which the legs of the crow-foot are extended.
Van. The foremost division of a fleet in one line. It is likewise applied to the foremost ship of a division.
Vane. A small kind of flag worn at each mast head.
To Veer or Wear the ship. To change a ship's course from one tack to the other, by turning her stern to windward.
Veer. Let out, as veer away the cable.
Veer. Shift. The wind veers, that is, it shifts, changes.
To Veer and Haul. To pull a rope tight by alternately drawing it in and slackening it.
Viol or Voyal. A block through which the messenger passes in weighing the anchor. A large messenger is called a *viol*.
Wake. The path or track impressed on the water by the ship's passing through it, leaving a smoothness in the sea behind it. A ship is said to come into the wake of another when she follows her in the same track, and is chiefly done in bringing ships to, or in forming the line of battle.
Wales, are strong timbers that go round a ship a little above her water-line.
Warp. A small rope employed occasionally to remove a ship from one place to another.
To Warp. To remove a ship by means of a warp.
Waist. That part of a ship contained between the quarter deck and the fore-castle.
Water line. The line made by the water's edge when a ship has her full proportion of stores, &c. on board.
Water-borne. The state of a ship, when there is barely a sufficient depth of water to float her off from the ground.
Water-logged. The state of a ship become heavy and inactive on the sea, from the great quantity of water leaked into her.
Water-tight. The state of a ship when not leaky.
Weather. To weather any thing is to get to windward of it. Synonymous with windward.
Weather-beaten. Shattered by a storm. *Weather-bit.* A turn of the cable about the end of the windlass. *Weather-gage.* When a ship or fleet is to windward of another, she is said to have the *weather-gage* of her *Weather-quarter.* That quarter of the ship which is on the windward side. *Weather-side.* The side upon which the wind blows.

To Weigh Anchor. To heave up an anchor from the bottom.
To Wind a Ship. To change her position, bringing her head where her stern was.
Wind road. When a ship is at anchor, and the wind being against the tide, is so strong as to overcome its power and keep the ship to leeward of her anchor, she is said to be *wind-road.*
Wind's eye. The point from which the wind blows.
To Windward. Towards that part of the horizon from which the wind blows.
Windward Tide. A tide that sets to windward.
To Work a ship. To direct the movements of a ship by adapting the sails and managing the rudder according to the course the ship has to make.
To work to windward. To make a progress against the direction of the wind.
Woold. To bind round with ropes.
Yards. The spars upon which the sails are spread.
Yawing. The motion of a ship when she deviates from her course to the right or left.

EVOLUTIONS AT SEA.

Of the Ballast and Lading.

WHEN a ship is loading, it should be considered that her tendency to pitch or roll depends not alone on her form, but even more upon the distribution of the heaviest parts of her cargo.

Particular attention is to be paid to moderate her pitching, as that is what most fatigues a ship and her masts: and it is mostly in one of these motions that masts are seen to break, particularly when the head rises after having pitched. Although the rolling be proportionably a more considerable movement than pitching, it is seldom any accident is seen to arise from it, as it is always a slow one. It is however not less proper to prevent it as much as possible. This will, in general, be easily obtained, without being any way detrimental to the ship's stiff carrying of sail, if, when the ballast is iron, you stow it up to the floor heads; because it will recall the ship with less violence after her having inclined, and it will act on a point but little distant from the centre of gravity.

In the merchant service the stowage consists, besides the ballast, of casks, cases, bales, boxes, &c. which are all carefully wedged off from the bottom, sides, pumpwell, &c. and great attention paid that the most weighty materials are stowed nearest to the centre of gravity, or bearing of the ship, and higher or lower in the hold, agreeable to the form of the vessel. A full low built vessel requires them to be stowed high up, that the centre of gravity may be raised, to keep her from rolling away her masts, and from being too stiff and laboursome; as, on the contrary, a narrow, high built vessel requires the most weighty materials to be stowed low down, nearest the kelson, that the centre of gravity may be kept low, to enable her to carry sail, and to prevent her oversetting.

To anchor in fine weather in a place where you will ride head to wind, being close hauled.

Being under the three topsails, fore-topmast stay sail, and mizen, stand on until you are within about two ship's lengths of the place where you mean to drop your anchor; then put the helm a-lee, and haul down the fore-topmast stay sail. As soon as the topsails shiver, clue them up briskly, before you lower, except the mizen topsail, which is to be laid to the mast, and the mizen sheet hauled flat aft, the instant the ship begins to have stern way, by reason of the wind being a-head. Then shift the helm to windward, and let go the anchor, veering away the cable, to give it time to settle in the ground, until the vessel falls off, when she is to be checked, to bring her head to the wind. When that is done, right the helm, and haul up the mizen.

To anchor in fine weather in a place where you will ride head to wind, the wind being large.

If you have the wind large, whether on the beam or more aft, the operation is still the same, only hauling up a little sooner to keep to windward, because it is in your power to drift as much as you think requisite, and because the ship will be entirely stopped as soon as all her sails begin to catch a back, and you will have done cluing them up when they begin to shake. The mizen topsail is next to be heaved to the mast, the helm put a-weather, and the anchor let go, as soon as the head way ceases; then after giving her a sufficiency of cable, bring the ship up. If she has been going large she will not range precisely head to wind, since her headway ceases as soon as the sails are taken a-back, and the effort of the wind acts on all the rigging of the ship to impel her

both a stern and to leeward, which is indeed augmenting the effect of the rudder, as the helm is a-weather to bring the vessel to the wind; but as the power of the wind is very great to pay the ship's head off, it balances, wholly or partly, (according as the ship goes a stern with more or less velocity) the effort of the rudder and that of the mizen: thus she drifts, and remains as it were lying to with all her sails aback. This is the reason why we keep a little to windward, and let go the anchor, to bring the ship's head to wind at the proper time, which she will do the more readily as she is withheld forward by the cable, while the wind on her side forces her to leeward.

To anchor in fine weather in a place where you are to ride head to the stream and wind, the wind being large.

If you are obliged to ride with the head to the stream, you must, when it comes from the windward, put the helm a-lee in setting the mizen, then clue up the sails: and when the ship's head is right in the direction of the stream, let go the anchor, provided she has quite lost her headway; for else, you would get foul of the anchor stock by running over it. This must never be neglected, unless you find yourself under the necessity to bring up in any situation in which you may happen to be, which is almost always the case when you are taken too short to have time to stop the vessel: a reason why there is often a necessity of casting a second anchor, which generally catches the ground by assistance of the first, which has begun to diminish the velocity of the ship; and as many of the sails are to be hauled down as you can, and as quick as possible.

To anchor in fine weather in a place where you will ride head to the stream, which comes from leeward, the wind being large.

When the current comes from the leeward, you must keep the ship away till her head comes to the set of the stream, and take in all the sails to diminish as speedily as possible her headway, which always continues of itself long enough when the wind is aft or very large; and when the ship is stopped by the effort of the water, let go the anchor without waiting for the vessel gathering stern-way, if the current is rapid; and in this case, as well as all those wherein there is a sea, or blowing fresh, the ship requires a great length of cable.

To come to an anchor with the wind aft.

First, hand the main topsail, and then lower the fore topsail down on the cap; and when you are within a reasonable distance of the place where you mean to drop anchor, (which distance is to be judged of from the readiness of the ship to obey the helm, and from her velocity) the tiller may be put either one way or the other, the fore topsail and fore topmast stay sail clued up and taken in, the mizen topsail braced sharp up, and the mizen sheet hauled flat aft. When the ship ranges close to the wind, she is, as it were, lying to under the mizen and mizen topsails, with the last mentioned sail full or a-back according as you may have occasion to shoot a-head or drop a-stern; so that if you are too much to windward of the spot where you mean to bring to, you drift till you arrive at it: if you are precisely in the proper birth, you let go the anchor in lowering down the mizen topsail, which is to be furled as soon as the vessel is brought up; then the ship will come head to wind by the power of the mizen, which must be brailed up as soon as it shakes.

Scudding under a foresail, to come to an anchor.

The foresail must be clued up when at some distance from your birth; and, some part of the way, run under bare poles. When near enough to sheer to the wind, you execute it by putting the helm hard a-lee; and as soon as the ship is come to, let go the anchor, giving her a large scope of cable, and observing to check her handsomely, in order to make her ride head to wind, as stopping her at first too short might endanger her cable or anchor. Should the first not bring her up, a second may be let go.

To anchor with a spring, in order to present the vessel's side to a place or ship you wish to cannonade.

This is executed when you know that the wind or current will bring your head, when at anchor, towards the object you mean to attack; for should the wind or tide bring your broadside to bear on the object you mean to cannonade, the spring would only be a precaution to get under way more quickly in case you were obliged to retreat, or in case the wind or tide should shift.

Get a large snatch-block in the aftermost port, or on the same side you wish to present to the wind or current, and on the same side with the anchor and cable with which you mean to bring up; then, through the block reeve a hawser, the end of which is to be clinched to the ring of the anchor you mean to let go; the other part is to be brought to the capstan with necessary ranges of the cable and hawser on deck. That

done, and the ship being arrived at the birth, you are to deaden her way according to circumstances; then let go the anchor, and veer away enough cable and hawser, now a little more of the one, and then a little more of the other, according as you wish to present more head or stern; which you can do by heaving on the spring, or what is the same, veering away more cable. Should you find it requisite to shift your position, you have only to veer out more of the hawser.

To come to anchor in roads that are often crowded with ships, and to leave clear births for others.

The best anchoring births in these places are mostly known by marks, and of course are occupied by the first ships.

In a tide or trade wind road-stead, the next ship that comes should not anchor right ahead or a-stern of the first ship and so as to lie in the other's hawse, but should come to on the bow and quarter at a sufficient distance to prevent other ships from coming between, and in a slanting direction from the tide or wind. This might contribute to the safety of ships when it blows strong upon a lee-tide or in strong sea breezes, as each single ship may then veer away what cable necessary, and keep clear of the other ship's hawse a-stern; or, in case of driving or casting, they have a better chance of keeping clear of each other.

To get up an anchor, in ships which have a main and jeer capstan.

In large ships which have a main and jeer capstan, and the strain is thought too great for the messenger alone, the viol is used thus: Three or four turns are taken round the jeer-capstan with one end, so as to leave that side clear on which the cable is coming in; and pass the other end through the viol block, which is lashed round the main-mast on the lower deck. It is then carried forward and passed round the rollers in the manger near the hawse holes; then brought aft, and spliced to the other end with a short splice, and the ends marled down tight. That side of the viol on which the cable is coming in is fastened to the cable by nippers; and thus the continued efforts of the capstan are conveyed to the cable, until it is hove in. The nippers are clapt on in the manger, from one to two fathoms asunder; and the viol is applied to the midships, or inside of the cable. Nippers are clapt on by taking three or four turns round the viol, four turns round the cable and viol, and then three or four turns round the cable. This method is an exceeding good one, and very suitable to quick heaving; but when the strain is great, and the cable muddy, the nippers clapt on after this method will not nip sufficiently, and some times recourse is had to the following method: Throw sand or ashes upon the cable, and take a long dry nipper, which middle and pass one half aft, racking it in and out round the cable and viol; then worm its end round the viol only. After this pass the other half in the same manner forward, but worm its end round the cable only, and let each end of the nipper be held on. The advantages of this method are, that as the strain of the cable lies forward and that of the viol aft, the nipper will be drawn so tight as effectually to hold the cable till something gives way: also they can never jamb, for both ends are clear for taking off. Another method, when the strain is great, is, to have nippers with an overhand knot made at one end; and with that end a round turn taken round the cable and viol, leaving three or four feet of the end; then with the other end, take three or four racking turns, and expend nearly the remainder with turns round the cable and viol, laying the knotted end under and over each of the last turns; the end is then held fast. The men who clap on the nippers are attended by boys, who hold the ends of them, and follow the progress of the cable as it is hove in; and, as the nippers arrive near the main hatch-way, they are taken off and carried forward, where they are again clapt on, and so in succession until the cable is hove in sufficiently to raise the anchor above the water. It is then stoppered round all before the bitts, that is, round the cable and viol. The anchor is then catted, and afterwards fished. To shift the viol for heaving in a second anchor, it must be unspliced, and the turns round the capstan reversed. When the strain is so great as to require other purchases, the top tackles may be used thus: the double block is lashed to the main-mast or topsail-sheet bitts, the treble block is lashed on the cable, and the fall is brought to the capstan. If the top tackle falls are thought insufficient, any hawser may be used that will reeve through the blocks.

To get up an anchor in ships which have not a jeer-capstan.

Ships without a jeer-capstan have no viol, but heave in their cables by a messenger, which has an eye spliced in each end, one of which ends is passed with three or four turns round the capstan on the upper deck, and the other end passed forwards round the rollers, at the fore part of the manger; then brought aft to the other end, and lashed thus: several turns are passed through the eyes crossing each other in the middle, then a half hitch is taken round the parts, and the end stopped with spun-yarn. The remainder of the operation is performed as by the viol, with this exception; the mes-

senger is applied to the outside of the cable, and when the nippers are insufficient, the messenger may be hitched thus: the bight of the messenger is fastened round the cable at the manger with a rolling hitch, and the bight seized round the cable before the hitch. This practice is by no means so good as the others.

When getting under way in a sea gale, the viol is better than a messenger, as the sending of the ship carries all the strain to the main capstan, and endangers the men at the bars, whereas with a viol, the strain is taken to the viol block, and the men at the fore jeer-capstan heave in security.

To get up a second anchor.

Suppose by the former methods, that the starboard anchor is got up, and that the cable of the second anchor enters the larboard hawse-hole, the operation of getting up the second anchor is the same, observing only, that the messenger must be shifted, and the turns on the capstan reversed, to change the disposition and side; and the men, who before held on the larboard side in the first operation, will hold on the starboard side now. The motion of the capstan is performed the contrary way, and the cable on the larboard side is fixed and hove in.

To get up an anchor in Merchant Ships.

Most merchant ships and small vessels heave up their anchors by a windlass, round which are taken three turns of the cable, and held on by hand, or by a jigger; thus—the end of the rope which has the sheave is passed round the cable, with a round turn, close to the windlass, the leading part of the rope coming over the sheave, and stretched aft, by means of the fall passing through the jigger block; the standing part of the fall is made fast round a stantion, at the fore part of the quarter deck, and the leading part is bowsed upon, which jambs the turns taken round the cable, and, when the jigger arrives abreast of the hatchway, it is removed forward, and the cable is jambed by a handspike at the windlass, until the jigger is refixed.

To weigh an anchor with the long boat.

This is done by taking the long boat to the buoy of the anchor, and putting the buoy-rope over the davit of the long boat, and a tackle on the buoy-rope; by which, with the assistance of men on the fall, the anchor is weighed out of the ground. This being accomplished, the cable is hove in on board; the buoy-rope and tackle being secured in the boat, they approach the ship as the cable is hove in, and the anchor catted and stowed. Small anchors and grapnels are got up by the davit, hauling upon the grapnel rope by hand.

To weigh an anchor by under-running.

This is by placing the cable over the davit-head, and under-running it, till it is nearly apeek, when it is tripped by means of tackles, as before by the bouy-rope. This method is troublesome, and is only adopted when the buoy is gone, and a ship cannot get near her anchor for want of water.

To get under sail when the ship is swinging head to wind, and you want to cast either to starboard or larboard, in a place where there is no current.

To cast to starboard.

Heave short on your anchor till it is apeek; then haul in quite home, the larboard braces forward, and starboard braces abaft; loosen, sheet home, and hoist the topsails; put the helm a starboard, and heave till the anchor is aweigh. The moment the anchor quits the ground, the ship will begin to fall off to starboard. As soon as this movement is perceived, hoist the jib and fore-topmast staysail, if necessary, to help her; and when she has sufficiently fallen off, her sails abaft (which are trimmed sharp for the larboard tack) will fill. But, unless for very superior reasons, you had better continue lying-to till the anchor is catted, taking care to haul the mizen-sheet close aft, if the ship be inclined to fall off too much.

To cast to larboard.

Haul in the starboard braces forward and the larboard aft, and put the helm a-port. The rest of the operation is the same as the preceding, only changing the starboard for port.

To get under sail when the ship is riding head to wind and tide.

If a ship, riding head to wind and tide, wanted to get under sail, after having decided on which side it is best to have her cast, it must be performed according to one of the foregoing methods, except with regard to the helm, which must be put to starboard either before the anchor loosens, or while it does, if you wish to cast to port; because the water coming from forward, acts with the same force on the rudder as if the ship went with the current, impelling the rudder to starboard and head to port. Therefore it is evident in this case, the helm ought to be put to starboard; which, on the contrary, would be put to larboard, if the ship were to be cast to port.

If the ship, after the anchor is out of the ground, goes astern faster than the current runs, the helm must then be used as if there was no current, because the excess of velocity, whereby the ship exceeds that of the water, acts upon the rudder.

If it blows fresh, so that you cannot set your topsails without reefing them, let that be done before they are sheeted home; and if it blows so hard as to be obliged to go only under a foresail, it would then be sufficient to loosen the fore-topsail, without sheeting it home, after having braced it quite close on the side opposite to that you want the ship to cast, not forgetting however to put the helm the same way as you cast, as soon as you perceive the ship going astern: and when the ship has fallen off sufficiently, then is the time to fill and trim the foresail.

To get under sail when the ship is swinging with her head to the current, and with the wind a point abaft the beam.

Heave short on your anchor till it is a-peek; next to this loosen, sheet home, and hoist the foresail and mizen-topsail, keeping the wind in, and heave vigorously at the capstan, till the anchor is a-weigh. At the same time hoist the jib and fore topmast stay-sail, or haul out the mizen, according as circumstances may require. Whether you wish to come to windward, or fall off more quickly, you must still continue to heave round the capstan briskly, to get the anchor up, till you find yourself sufficiently off-ward to bring to, in order to stow it with ease, or to stand on under an easy sail with the anchor hanging out to windward, if the situation of things will admit of it. You may sometimes also hoist up both the main and fore-topsails, as soon as you get ready; but in certain cases, as when obliged to make the best of your way from an enemy, every sail possible must be set at once which the weather will admit of, especially when obliged to haul by the wind; in which case, the anchor must be got up and catted as well as it can; there are cases even when, without losing your time in weighing it, you crowd as many sails as you possibly can, and depart, in cutting or slipping the cable.

To get under sail with a spring.

If a ship be in a place too confined to cast under her sails only, or being obliged to put to sea in a gale of wind, without hoisting the anchors, you must, for greater safety, in casting the right way, get a spring out, to be clapped on the cable by which the ship swings, by passing a hawser or a stream cable through the aftermost port, on the opposite side to that you mean to cast; and after that spring is well hove tight at the capstan, hoist the jib and fore-topmast-staysail, loose and sheet home the fore-topsail; when that is done, and if the weather permits, brace quite close the head sails, on the same side with the spring. When this is executed, slip or cut the cable, heaving briskly at the same time on the spring, till the ship has paid off sufficiently. Then fill the sails, by setting the mizen-topsail and every other sail you mean to employ, and slip or cut the spring, as circumstances may require. Care must be taken, not to let the ship fall off too much, before the spring is cut; because, having no way through the water, she will not come to the wind so soon as might be wished; and for the same reason the spring must not be cut, till she has fallen off as much as is necessary; because, although she has no other motion but that of falling off, the vessel might perhaps not wear enough to answer the purpose.

To get under sail with a leading wind, in a tide way.

If the ship to be got under sail has a leading wind, and is in the midst of vessels, or in a narrow channel, where it would be difficult to cast her upon the lee-tide, she should be got under sail before the weather-tide is done. Thus, the casting of the ship would be avoided, and she may be steered through the fleet or channel with safety.

Should it, however, blow so fresh upon the windward-tide as to force the ship end on with her cable, it will be impossible to heave it in, without sheering the ship over from side to side, and heaving in briskly as the ship slacks the cable; but as this is attended with much danger, by the ship suddenly bringing up upon each sheer, it will be best to heave a-peek upon the first setting of the windward tide, before the ship swings to bring the wind abaft.

To cast a ship upon the larboard tack, and back her a-stern of danger.

We suppose the ship to lie at single anchor, with the wind and tide the same way, and ships or shoals right astern, in the intended course, and that to clear them, you must cast upon the larboard tack, and make a stern board.

Make every thing as ready as possible before weighing: let the three topsails be hoisted, the yards braced up sharp with the larboard braces, and the mizen hauled out. Thus situated, when the anchor weighs, put the helm a-port. The tide, running aft, acts upon the starboard side of the rudder; and in that direction it will cast the ship the right way, and bring the wind upon the larboard bow. The wind being on the larboard bow, and the topsails a-back, will soon give the ship stern-way through the water; then the water will act against the larboard side of the rudder, and powerfully prevent

the ship falling too fast off from the wind. Thus she will drive till the anchor is got quite up, and may be so continued till she has past the shoals and has room to veer, and get upon her proper course.

It is advantageous to make a stern-board in getting under way from a single anchor in the above situation. The anchor heaves up more easily when the ship goes a-stern; and while heaving up it serves to keep the ship's head to the wind. A ship, however, cannot long be steered stern foremost when under sail, so as to keep the wind before the beam; but she will in a little time drive broadside through the water till she gets head-way, and then it is proper to veer, provided the anchor be quite up.

To cast a ship on the larboard tack, in a tide-way, with the wind two points on the starboard bow.

A ship, riding in a tide-way, with the wind two points on the starboard bow, and so near the shore on the larboard side, that she must be cast upon the larboard tack, to clear the shore, the three topsails must be hoisted, and the yards sharp braced up, with the larboard braces forward, and the starboard braces aft, with the starboard foretop bowline well hauled, putting the helm hard to port at the anchor's weighing; the tide acting upon the rudder, and the wind upon the sails braced in that direction, brings the ship about with the wind on the larboard bow, before she gets stern-way, which should be always strictly noticed; for in all proceedings of this kind, if a ship gets stern-way before she brings the wind right ahead, she will not come about the right way. In that case, it is best to veer away the cable directly, and bring the ship up again: and carry out a kedge or small anchor on the larboard bow, hauling its cable or hawser in tight on the larboard quarter, when the bower anchor is a-peck. If this fail, the ship must lie till the windward tide makes, to bring the wind on the larboard bow, when the ship may be got under way, and clear the shore.

To cast a ship upon the larboard tack in a lee-tide, and shoot her by the wind a-head of danger.

If there be just room enough to go close by the wind to clear a danger lying to leeward, much depends on heaving up briskly the anchor after it is out of the ground, and having proper sails ready to set to the best advantage. The three topsails must be hoisted, and the yards sharp braced up, with the larboard braces forward and the starboard braces aft, when the anchor is at a long peek. At weighing the anchor, put the helm hard to port, then the action of the tide upon the rudder, and the wind on the fore-topsail, will cast the ship off the right way, so as to fill the after-sails, when the fore-topsail may be soon braced about and filled before she gets stern way. The helm will keep the ship under command sufficiently to steer her by the wind ahead clear of danger; but if the ship gets stern-way in casting, the helm should be kept hard a-weather, to prevent her falling off too much from the wind; and when she gets headway again, be cautious how the weather-helm is eased with the anchor much below the bows, by which the resistance forward is increased, and the ship may be brought up in the wind, so as to prevent her shooting clear of the danger. This must be guarded against by the weather-helm and head sails, as jib, fore-topmast-stay sail, &c. As soon as the ship has shot far enough a-head to clear the danger to leeward, and there being but little room a-head, it is best to bring the ship to, and drive with the helm a-lee, with the main and mizen-topsail a-back, and the fore-topsail shivering till the anchor is up; then take proper time to veer.

To cast on th larboard tack, when riding with the wind right a-head, and to veer her short round before the wind in little room.

The head sails should only be loose, viz. the fore-topsail hoisted and the foresail loose; brace sharp up the larboard braces, the jib and the fore-topmast-staysail set, with the larboard sheets flat aft. When the anchor is a-peck and a lee-tide running, at weighing the anchor, the helm should be put to port so far as to bring the wind two points on the larboard-bow, which should be kept so by steering the ship till the tide ceases to run aft. Then put the helm hard to starboard, or a-lee; and when the ship gets stern-way, the water will act powerfully on the starboard, or lee-side of the rudder, turning the ship's stern to windward, whilst the wind, acting at the same time upon the head sails a-back, will box her round off upon her heel, so as to bring the wind nearly aft by the time she loses stern-way. hen the ship will cease falling off, and soon get head-way, which should be attended to, and the head sails braced about flat with the starboard braces, and the helm shifted hard to port at the same time.

When there is no tide, but still water, at weighing the anchor, the helm must be hard to starboard; and, as the ship gets stern-way, the water meets with so much resistance against the starboard side of the rudder in that direction, that the rudder acts with great power to turn the ship's stern round to port, and the head sails being set and trimmed as before mentioned, and the foresail let fall with the starboard bowline hauled

close forward, will assist to cast the ship so far round the right way, by the same time she loses her stern-way, as then to permit your proceeding as before directed. To insure success, heave the anchor up briskly. The same methods are adopted in casting the ship on the starboard-tack, only the helm and sails are managed the contrary way.

To tack a ship in getting to windward as much as possible.

To execute this with propriety, care must be taken that the ship does not yaw, that she is not too near or too far from the wind; because both situations are equally prejudicial.

When this medium is obtained, haul the mizen out, while you put at the same time the helm a-lee, brace the sail to windward, in order that it may be as much as possible exposed to the wind. When the ship is come to the wind, so as to cause the square sails to shiver, let go the jib, and all the staysail sheets before the mainmast. At the moment when all the sails catch a-back, and particularly the mizen-topsail, let it be braced sharp about the other way, hauling up at the same time the weather-clew of the mainsail; and when the wind is right a-head, or even a little before, haul the mainsail, and trim sharp for the other tack as fast as possible. The jib and staysail sheets are also to be shifted over, at the same time righting the helm, whether the ship has lost her way, or even still advances a-head. Then as soon as she has passed the direction of the wind about 45°, in continuing her evolution, shift the foremast's sails, which are to be trimmed with celerity, at the same time putting the helm a-lee, if you fear the ship (which must still go a-stern if the operation be slowly executed) will not fall off sufficiently; for, if the sails are braced about briskly, she will never have stern-way; on the contrary, she will get a great deal to windward.

To tack a ship without endeavouring to get to windward.

There are circumstances sometimes when it is found necessary to tack, without caring much whether the ship loses to windward or not. For example: when a ship is found suddenly to be close to the land, in the night, or in foggy weather, near a danger or some vessel, which must instantly be avoided by staying the ship, because you find yourself to windward, and too near the object from which you wish to recede: in this case, when it is necessary to deaden the ship's way, and tack at the same time, you must suddenly put the helm hard a-lee, and in the same instant, let go the jib, fore, and staysail sheets, without touching the bowlines; and great care must be taken that the effect of the mizen is to be preserved as much as possible. When the sails begin to shiver, the mizen is hauled quite to windward; then, if the ship takes well the wind a head, the remainder of the operation must be executed as directed in the preceding case; but, if you should miss stays, you must proceed according to the second method of veering, called box-hauling.

To tack a ship in a dangerous rough sea, when her staying is doubtful.

Let every thing be got clear and ready; the hands at their proper stations, the sails trimmed fair, and the ship steered just full, and close by the wind. Take the advantage of the smoothest time, when the ship has the most head-way. The other necessary precautions are, to haul down the jib, if set, and not to put the helm a-lee all at once, but to luff the ship up by degrees, to shake the sails. When they shake, give these orders: the helm hard a-lee! let go the lee sheets forward, but not the lee braces and fore-top bowline, as that usual practice backs the head sails too soon, and stops the ship's head-way, which ought to continue to give power to the helm, till the wind is brought a-head, or the ship will not stay. Raise tacks and sheets and mainsail haul, when the wind is a point on the weather-bow; this swings the yards round sharp, that the main-tack may be got close down, whilst the head sails becalm the fore-leech of the main and main-topsails; while the wind, blowing aslant on the after-leech of these sails, acts jointly with the rudder to turn the ship's stern, so as to bring her about the right way. When she has fallen off five or six points, let go and haul.

When a ship comes about, she is sure to have stern-way by the time the head sails are hauled, therefore the helm should not then be shifted a-lee, but should be kept hard a-weather, till her stern-way ceases. The water, acting upon the weather side of the rudder, prevents the ship falling around off from the wind, which the helm, when hard a-lee, occasions, while the stern-way continues. Notice should be made by the compass, that the ship continues coming about till the wind is on the other bow; for if she stops with the wind a-head, and her head-way is perceived to be done, the helm should be directly shifted to the other side, so that, by the stern-way, the water may act upon the rudder and bring her about, and then the helm should not be kept a-lee, but directly shifted and kept hard a-weather till her stern-way ceases. For the reason just given, the head sails may be hauled as soon as possible; for, the ship will be sure to fall off the faster and further in proportion to her stern-way; so that the weather-braces should be tended to prevent the head yards flying fore and aft, as they will do when it blows fresh: and

to keep the head sails shivering, that the fore-tack may be got close down easily, and the ship stopped the sooner from falling off. Shift the helm a-lee when the stern-way ceases, and the head sails may be trimmed sharp as the ship is perceived to come to.

On turning to windward in very narrow channels.

At weighing, if the wind is partly across the tide, it will cast the ship with her head towards the weather-shore, which she may be kept clear of, by driving with her sails a-back till the anchor is up and stowed; and, as the tack towards the weather-shore is the shortest, it is prudent to back as near the lee side as possible, in order to make the first board the longer; to get the three top-sails, jib, stay-sail, and mizen, properly set; and to get all ready in time for tacking. Make as bold as possible with the weather shore, because on that side a ship is always surest in coming about; and in case of missing stays, a ship may be backed off from the weather-shore, till she has room to fill and set the sails, and get sufficient head-way to try her in stays again without danger. But when the ship is got about, and standing towards the lee-shore, it may be necessary to put her in stays in good time, because she does not so certainly stay when going slanting with the tide, as when going across it.

By staying her thus in good time, if she even miss stays, there may be room enough to fill and try her the second time, or to use such means as may prevent her going on shore.

But, when the wind is right against the tide which begins to make to windward, be cautious not to weigh the anchor till the ship swings end-on to the tide, and brings the wind so far aft, that she may be steered right against the tide, till the anchor is up and stowed, and the sails with which the ship is to work are all ready.

Haul the wind and get ready for tacking, when you are close over to one side, to gain the whole breadth of the channel for getting under way. For this purpose let the first trip be made as short as possible, till it is found how the ship works upon both tacks; and then make longer or shorter boards accordingly, but take care not, to stand into an eddy tide on either side, which has often occasioned ships to miss stays and go on shore. If a ship will not stay, she must be veered, box-hauled or club-hauled.

To veer a ship without losing the wind out of her sails.

To execute this evolution both the main sail and mizen must be hauled up, the helm put a-weather, and the mizen-topsail a shivering, which will be kept so till the wind be right aft, suppressing for that purpose the effect of all the staysails abaft the centre of gravity. As the ship falls off, (which she will do very rapidly) round-in the weather-braces of the sails on the fore and mainmast, keeping them exactly trimmed to the direction of the wind, and remembering also that the bowlines are not to be started till the ship begins to veer. As she falls off, ease away the fore-sheet, raise the fore-tack, and get aft the weather-sheet, as the lee-one is eased off, so that when the ship is right before the wind, the yards will be exactly square. Then shift over the jib and staysail-sheets; and the ship continuing her evolution, haul on board the fore and main tacks, and trim all sharp fore and aft, remembering to haul aft the mizen and mizen-staysail sheets as soon as they will take the right way, or when the ship's stern has a little passed the direction of the wind. When the wind is on the beam, right the helm to moderate the great velocity with which the ship comes to; the sails being trimmed, stand on by the wind.

To veer a ship that has lost her foremast.

Run out the end of a cable or hawser over the lee-quarter, and buoy it up from the ground with empty casks, &c. in case of coming into shoal water with little wind. This will assist the helm with such power, as to make the ship veer and steer at pleasure.

A spare yard or boom, rigged out abaft the mizen shrouds, may guy the end of the cable or hawser more or less on either quarter, according as the ship may have occasion to sail. It may be easily shifted from side to side, and guyed out to leeward in proportion to the ship's griping to answer sailing upon both tacks; and, when sailing before the wind, it may be secured over the middle of the stern, which will prevent the ship's broaching to against the helm either way.

This would likewise much assist deep laden bad-steering ships, and prevent their broaching-to, to which they are liable, in spite of the best helmsmen, often occasioning them to lie to even with a fair wind. With a little contrivance by blocks lashed to the rails on the quarters, to lead the guys fair to the steering wheel barrel, it may be made to steer a ship that has lost her rudder.

To veer when lying-to under a mainsail.

Advantage must be taken of the ship's falling off to put the helm a weather, and ease away the main-sheet roundly; and, when the ship has fallen off about 50°, let go the main-bowline, and round in the weather brace, taking care to keep the sail full. When

the ship is before the wind, get on board the main-tack, and right the helm to moderate her coming to.

If, in the beginning, the ship is found difficult to veer, the fore stay-sail may be hoisted, and the sheets hauled well aft; but it is to be hauled down as soon as the ship is before the wind.

A second method.

Make fast a four inch rope to the strings of the main yard; and when the ship comes-to, so as to shiver the main sail, bring it down before the sail to the topsail sheet bitts, and let it be hauled tight and belayed. Then, as soon as she falls off, put the helm a-weather, and let go the main sheet. By these means, the lee part of the sail no longer has any power to keep the ship to the wind, and the weather part, acting before the centre of gravity, will cause her to veer faster than by the first method; though, in general the first method will answer the purpose.

To veer under bare poles.

The fore-staysail must, if circumstances will allow it, be hoisted. But if that cannot be done, the head yards are to be braced up as sharp as possible, and those abaft pointed to the wind. Then, if the ship veers, she will steer under the masts and ropes only. A number of seamen sent up and placed close to each other in the weather fore-shrouds will be found also of very great service.

To box-haul a ship, or the second method of veering.

In this evolution the most rapid execution is necessary. Briskly, and at the same instant, haul up both the mainsail and the mizen; shiver the main and mizen topsails; put the helm hard a-lee; raise the fore tack; let go the head bowlines, and brace about the head yards sharp the other way; and let the jib and staysail sheets go in the same instant. When the ship has fallen off 90°, brace the after yards square in order to give the ship a little way, and to help her (with the rudder, the situation of which must be changed) to double the point where all the sails shiver; and when the wind is aft, you will proceed as in the method of "veering without losing the wind out of the sails."

If the circular motion of the ship, after she has fallen off 90° continues pretty rapid, the filling of the after sails, to give the ship headway, may be dispensed with; because she continues to turn by the effect of her helm, which must not be shifted, since the vessel still continues her stern-way. Therefore, after having veered a few degrees more, the wind will fill all her sails, and the ship consequently will have head way. Then change the situation of the rudder to bring her before the wind.

In a case of absolute danger, when it might be necessary to go a-stern and fall off more rapidly, put the helm a-lee, brace all the sails a-back, and observing not to brace the after sails more than square, that they may not counteract the head sails, which are braced sharp a-back to pay the ship's head off; because the effect of the after sails, in this situation, is to impel the ship abaft in the direction of her keel, which, with those forward, contribute to give her fresh stern-way, in order to cause the ship to veer with greater celerity. The jib and fore-topmast-staysail sheets being hauled over to windward, will assist the ship in falling off and going astern.

Box-hauling is deemed the surest and readiest way to get a ship under command of the helm and sails, with the least loss of ground to leeward, when a ship refuses stays. The masters of sloop rigged vessels, turning to windward in narrow channels, when they want but little to weather a certain point run up in the wind till the head-way ceases, then they fill again upon the same tack; this they call making a *half-board*. Thus a ship in box-hauling may be said to make two half-boards, first running with her head, then with her stern, up in the wind; by which two motions a ship rather gains to windward.

To club-haul a ship.

Club-hauling is practised when it is expected that a ship will refuse stays upon a lee-shore: place the hands to their stations for putting the ship about, and some by the lee anchor; then put the helm down, and if the ship make a stand before she brings the wind a-head, let go the anchor and haul the mainsail. When the wind is a-head, cut the cable, and the ship will cast the way required. The after sails being full, let go and haul.

Another method.

Bend a hawser to the kedge-anchor on the lee-bow, and bring the end into one of the after ports, or over the taffarel. Let go the anchor, brace up all sharp the contrary way, put the helm a-lee, and haul in briskly on the hawser. As soon as the ship gets headway, cut or slip the hawser, and carry a press of sail.

To lie-to to windward of a ship, so as not to drift near her.

The main-topsail must be braced sharp a-back; keeping the fore and mizen topsails full; because the wind acts with a very small sine of incidence on a sail when full, in comparison to what it does when braced sharp a-back; so that the fore-topsail, being full, draws the ship a head, and the effect of falling off is opposed by the main and mizen-topsails. She will of course not fall off much; nor will her lee way be very considerable; for the ship is well kept to the wind by the disposition given to her sails.

To lie-to under the lee of another ship.

The fore topsail ought to be braced sharp a-back, the main and mizen topsails kept full; because these two last mentioned sails tend to give the ship head-way, and keep her to the wind; they may be assisted by the mizen, which will oppose the falling off occasioned by the fore-topsail. Thus, should the ship to windward fall off violently, or drift too much, you are more ready to veer short round, and avoid being boarded; because the fore-topsail being braced sharp a back, the impulse of the wind on it is much greater than if it were full: and it is well disposed to veer suddenly, as soon as the power of the other sails is suppressed.

To bring-to with the fore or main topsails a back to the mast or filled.

Either the fore or main-topsail must be braced sharp a-back, and the lee-bowline hauled up a little; the other two topsails trimmed sharp, with the mizen hauled out, and the helm a-lee.

If you bring-to with the fore-topsail to the mast, the head yards may be only laid square. Then the wind will act obliquely on the sail, and the ship will fall off but little, because the effect is in the direction of the keel from forward aft, and the sails abaft, keep the ship to. The main-topsail may be worked in the same manner, if you wish not to expose yourself much to the wind.

To bring-to with the three topsails a-back.

The jib and staysails being hauled down, brace sharp round at once all the sails you wish to lie a-back in hauling up the lee-bowlines, the better to expose the sails to the action of the wind; haul out the mizen, and put the helm hard a-weather.

To fill when lying-to with the fore-topsail to the mast.

Brail up the mizen, hoist the jib and foretopmast-staysail, shiver the main and mizen topsails, and when the ship has fallen off 20° or 30°, fill the fore-topsail, which was a-back before, and stand on.

To fill when lying-to with the main-topsail to the mast.

Brace sharp and briskly the fore-topsail a-back; shiver the main and mizen topsails; hoist the jib and fore-topmast staysails, and brail up the mizen, all at the same time; and when the ship has fallen off 20° or 30°, fill the fore-topsail and stand on

If you are obliged to keep the wind on the same tack as that on which you are lying-to, you have only to right the helm, fill the topsail which is a-back, and trim it sharp, to continue your course.

A second method.

Trim the topsail which was to the mast, in order to give the ship way through the water, and be able to tack or run large, according as may be found necessary. But this method is very tedious, unless you mean to heave in stays; in which case it will be most expeditious.

A third method.

Shiver the main and mizen topsails, keeping the fore-topsail full, righting the helm, and running up the jib and fore-topmast staysail at the same time. As soon as the ship has fallen off enough to get headway, fill the after sails, and keep the ship in the direction you mean to follow. It is easily seen that this method, though the most common, is not the most expeditious, when you have to veer considerably.

To fill when lying to with all the sails to the mast.

Brail up the mizen, lay the after yards square, and shift the helm a-lee. When the ship has fallen off sufficiently to fill the after sails, those forward are then to be braced about and trimmed full also, in order to stand on.

Of lying-to in a gale of wind.

To lie-to when it blows hard, keep as close to the wind as possible under some one sail well trimmed, with the helm lashed a-lee as much as may be requisite for the ship; and as ships commonly bring to from the stress of contrary winds, care should be taken to heave-to under such sail as will least strain the ship; because there are some ships

which lie-to better under the foresail than mainsail, others are more easy under the mainsail, some under a mizen, and many vessels lie-to best under a main staysail.

Lying-to under a foresail.

This is advantageous for veering when you are well to windward; but it augments the lee-way, and is more subject to break the sea on board, on account of the ship's continual falling off, because in that movement she gathers way by yielding to the impulse of the gale, and is afterwards recalled to the wind by the helm; so that in springing the luff she meets the wave which comes from to windward.

Lying-to under the mainsail.

The ship does not in this situation fall off so easily as in the last mentioned mode, because its effect passes abaft the centre of gravity of the ship; but it keeps the ship more to the wind, and consequently occasions less lee-way.

Lying-to under the mizen.

Under the mizen, ships keep better to the wind than under any other sail, because it is farther abaft the centre of gravity than any of the rest, consequently ought to keep the vessel from drifting more than any of the others; but it is inconvenient should you have occasion to veer suddenly.

Lying-to under the main staysail.

Under the main staysail a ship will not make so much lee-way as under a foresail, because its efforts pass very near the centre of gravity; but it will, however, cause her to drift more than the mainsail; so that this mode of lying-to is a mean between the two others, and is preferable when it blows strong enough for that sail to support the rolling of the ship. It ought likewise to be preferred, because the ship will veer under that sail, the action of which passes at a small distance from the centre of gravity, and the power of the sail overcomes the resistance which all ships meet from the fluid under their lee; a resistance which always gives them a great inclination to fly up in the wind when it blows hard, or when under a heavy press of sail.

Lying-to under the fore, main, and mizen staysails.

All the preceding modes of lying-to have their peculiar faults; but the preferable way is under the fore staysail, the main staysail, and mizen staysail; because under these sails the ship will steer, and is in a better situation for veering than under any other sail; for only haul down the mizen staysail and put the helm a-weather, when the two other sails, being before the centre of gravity, will cause her to fall off; she will then soon gather way, and steer easily.

Should the gale continue very hard, and one of those staysails be blown away, the loss is not of much consequence, as the courses, in case of an emergency, are ready to set; whereas the courses are not so readily replaced when lost. This mode therefore appears preferable in every respect,* whether you wish to veer or keep your wind; because if the ship does not sufficiently keep the wind, you may haul out the balanced mizen, or take in the fore-staysail, or even the main stay sail. One of these staysails, before the centre of gravity of the ship, is sufficient to make her veer as soon as the after ones are suppressed. There are besides, these following considerations for so doing: the ship will carry sail better; because, as the centre of effort of those on her is very low; she drifts less, holds a better wind, and goes faster through the water; and these three or four sails are so situated as to give the whole body of the ship play, which will strain her less than when under one single sail, which cannot by itself work it from aft forward.

Of sounding in fair weather, whether close-hauled, or going large.

Close-hauled.

If close-hauled, brail up the mizen and mizen-staysail, let go the main sheet that the sail may shiver, put the helm a-lee, and back the mizen-topsail by bracing it square. The head-sails as well as the jib and staysails, are to be kept in their first situation; recollecting to haul tight and belay the lee braces. When the ship has nearly lost her headway, though continuing still to come to the wind, yet catch that moment to heave the lead, and it is to be hauled in again with all possible despatch. To fill again, haul aft the main-sheet, trim the mizen topsail, and right the helm.

Going large.

In going large you have only to put the helm a-lee, to brail up the mizen, and belay the lee braces quite tight, to prevent the yards having too much play when the sails are

* Should the sea run too high for the lower staysails to keep the ship steady, a close-reefed maintopsail will be found to answer the purpose admirably.

shivering. It is impossible to tack in this situation, as the jib and head-sails are always in action: and the square-sails soon coming to shake, on account of their sheets not being tacked, they lose all their power, and the ship is soon at a stand.

Another method preferable to the former.

Going large.

Brace the headsails square, haul down the jib and staysails, without stirring the after sails, and put the helm a-lee. While the ship has still a little headway, heave the lead from the place where you haul it in: that lead will go first a little a-stern, but the ship being head to wind, will soon herself go a-stern right upon the line; and as the helm is a-lee, the ship easily veers. But, if you wish to keep her to longer, right the helm and haul the mizen out, to prevent the ship's falling-off.

If you have studding sails set, they must be hauled down, particularly the lower ones; because, should the wind take them aback, their power on the boom might bring the ship round entirely, for they act on a lever without the ship, the fulcrum of which is on the outside of the vessel before the centre of gravity. If, however, the helm is continued a-lee till the ship falls off, she will not come about, because then the vessel goes a-stern with great velocity, and the rudder acts powerfully to make her veer; but the fact is, that the ship will go a great deal a-stern, and will continue to do so much longer.

Close-hauled.

If close hauled, or a very little from the wind, the helm is to be put a-lee, and the instant the sails are taken a-back the headsails are to be filled by briskly bracing them square, without waiting for the wind being right a-head; then a little before the ship has lost her way, heave the lead from the place where you haul it in, and then proceed as before.

On ship's driving.

When it happens that there is not sufficient room to work in a tide's way, through a crowd of ships, or in a narrow channel, but that the ship must drive by the help of the tide, it may be done, provided the tide be strong enough in proportion to the wind. This art consists in keeping the ship in a fair way, by a management of the rudder and the sails.

To drive to windward, when the wind is against the tide.

If the channel is sufficiently broad, the ship should be drifted broadside to the wind, as the tide will then have the greatest power on her; and could the ship be backed a-stern or shot a-head at pleasure, she might be kept drifting upon the same tack with safety; but ships in a tide's way can never be backed so far a-stern as they will shoot a-head. At the first of a stern-board, a ship will go briskly a-stern, but will soon fall off, and drift with the wind abaft the beam, forging a-head; for this reason she must be drifted with the helm a-lee. It follows, as a ship will shoot more a-head than she can be backed a-stern, that she will at length arrive at the opposite shore, when she must be stayed or veered and drifted upon the other tack. If she is to be stayed, (which is preferable, because less drift will be lost by it) let the sails be filled in time to give the ship sufficient headway to bring her about, then put the helm a-lee. Should she come about, the sails and helm having now a proper position for a sternboard upon the other tack, need not be touched till her sternway ceases, when the helm must be shifted a-lee: but should the ship refuse stays, then brace sharp round the headyards, and boxhaul her, by which method she will lose much less drift than by veering.

If the ship now drifting broadside, is approaching a narrow channel, where drifting in this position, she must be veered and dropped, stemming the tide stern foremost. In this case, that the drift may be as much as possible, it will be necessary to take in sail, and reduce the ship's headway till she has only steerage way left; thus a vessel may be dropped through a fleet of ships at anchor without danger.

To drive when the wind is across the tide.

Should the wind be a little across the tide, a ship may be easily drifted in the fair way, with her head towards the weather shore; for thus it will be found that she can be backed and filled at pleasure, and generally be drifted with the sails shivering, in which position they oppose least power to prevent the drift.

It frequently happens, in serpentine rivers, that the tide sets across; in this case the ship must be drifted with her head to the side from which the tide sets. These sets are best discovered by observing the opening or shutting of two objects in the direction of the channel.

To bend a course in fair weather.

Stretch the sail a-thwart the deck, the starboard side of the sail to the starboard side,

the larboard to the larboard side; then bend yard ropes to the ear-ring cringles, and make fast the head ear-rings a few feet up upon the yard-ropes. The bunt-lines, leech-lines, clue garnets, and all the geer bent, make fast a rope-band to each bunt-line and leech-line leg, that the men may be enabled to catch the head of the sail from the yard. Now man well the yard ropes, bunt-lines, leech-lines, and clue-garnets, and run the sail up to the yard. The sail aloft, send the hands up to bring it to, and let them haul out the weather ear-ring first, then the lee; and, if it is a new sail, let them ride the head rope to stretch it. The sail being hauled square out upon the yard, make fast the rope-bands, keeping the head of the sail well upon the yard.

To bend a topsail in fair weather.

Overhaul the leeches of the sail, put in the ear-rings, bend the bow-line legs, lay out the clues, and open them if necessary, and make the sail up snug again; then round down upon the lee-topsail-haliards till the weather fly-block is high enough to bring the sail up over the guard-iron: then rack the tie over the weather rigging. Now pile the sail upon slings, with the lee-side uppermost: hook on the topsail haliards, and run the topsail up into the top: then stretch the sail round the fore-part of the top, bend the jeer, and make fast the head ear-rings a few feet up upon the reef-tackle-pendants, with a rope-band or two to each bunt-line leg. The jeer being bent, man the reeve-tackles, bunt-lines and clue-lines, and haul out the sail. Now let the hands lay out upon the yard, and haul out the weather ear-rings first; then haul out to leeward, and ease off to windward till the sail is square, when make fast the rope-bands, keeping the head of the sail well up upon the yard.

To set a mainsail or foresail.

Before the sail is loosed, let the double block of a tackle be made fast to the weather-clue, and the single block be hooked low down upon the chess-tree, and the fall led aft. Then man well the tack and fall at the same time; and when the sail is loosed, ease away the weather-clue garnet let go the bunt-lines and leech-lines, bowse down upon the tackle, and take in the main-tack; the main-tack being down, haul aft the sheet, brace up the yard, and haul the main-bowline.

To set a topsail.

Let a tackle be in readiness to clap on either sheet as may be required. First man the lee-sheet; and, the sail being loosed, ease down the bunt-lines and lee clue-line, and haul home the lee sheet; then haul home the weather sheet, hoist the sail, and brace up as required.

Should the wind be quartering, the lower and topsail yards should be braced well into the wind, before the sail is sheeted home.

To take in a course.

Man well the weather clue-garnet, ease off the tack and bowline, and run it up; then, man the lee clue-garnet, bunt-lines, leech-lines, and weather braces; and being all ready, ease away the sheet, haul up the clue-garnet, bunt-lines, and leech-lines, and round in the weather-brace, till the yard is pointed to the wind. Then haul tight the trusses, braces, lifts and rolling tackle, and let the hands furl the sail.

To take in the foresail in the time of veering.

When the ship begins to veer, the yard being kept braced sharp up, let go the tack and bowline, and haul up the weather clue-garnet. When the ship is nearly before the wind, the bunt and leech-lines, and the other clue-garnet may be hauled up; and if the situation admits of it, and occasion requires, the ship may be steered with the wind on the quarter, till the sail is secured.

To take in a topsail.

There are many opinions upon the best mode of performing this. Some approve of cluing up to windward first, and others to leeward. If the weather-side is to be clued up first, the weather brace must be rounded well in, and the yard got close down upon the lifts, otherwise the lee rigging will be in danger of being carried away by the great pressure of the lee yard-arm. If the weather brace can be rounded well in, and the yard be got close down, it will be best to clue up to windward first, for thus the sail may be taken in without a shake, but, if the weather-brace cannot be hauled in to ease the yard off the lee rigging, recourse must be had to cluing up to leeward first. In this case, it will be best, if hands can be spared, to man both the clue-lines, bunt-lines, and weather-brace, at the same time; thus, when the lee sheet is eased off, the weather-brace may be hauled in with ease, and the yard laid to the wind; and, when the lee clue-line is half up, ease off the weather-sheet, and run up the weather clue-line; then haul tight the lee brace, bowse tight the rolling tackle, and furl the sail.

To take in a jib.

Man well the down-haul, let go the haliards, ease off the sheet, and haul down briskly; and, when the sail is close down, ease away the out-haul, and haul the sail into the bowsprit cap; then let it be stowed away in the fore-staysail netting.

To haul in a lower studding-sail.

To haul in a lower studding-sail, blowing fresh, lead one of the sheets clear aft, and man it well: then lower away briskly the outer haliards, to spill the sail; ease off the tack, run in upon the sheet, and lower away the inner haliards as required.

To haul down a topmast studding-sail.

Man well the deck sheet and down haul, ease off the haliards, and haul the yard close out to the tack block; then ease away the tack, and haul down both upon the deck sheet and down haul.

To brail up and haul down a main-topmast-staysail.

Man well the lee brail and down-haul, having a few hands to gather in the slack of the weather brail; then let go the haliards, ease off the sheet, and haul down and brail up as briskly as possible. When the sail is down, let go the tack, and stop the sail over to the lee fore-rigging.

To brail up a mizen.

Man well the lee brails, ease off the mizen sheet, and brail up briskly, taking in at the same time the slack of the weather brails. After the sail is hauled up, stop its foot by passing the gasket round to leeward which will spill it.

To take in top-gallant sail.

The lee sheet must be started first and clued up, and then the weather sheet.

To unbend a course.

First furl the sail, then cast off the rope-bands and make them fast round the sail, clear off the gaskets. When the rope-bands are all off, ease off the lee ear-ring, and lower down the sail; and, when the people upon deck have got hold of the lee part of the sail, ease away the weather ear-ring.

To unbend a top-sail.

First cast off the points of the reefs, keeping fast the ear rings; then furl the sail and cast off the rope-bands, which make fast round the sail, clear off the gaskets. After this cast off the lee ear-rings and haul the lee side of the sail into the top; then haul in the weather side. Now unbend the reef-tackle, pendants, bunt-lines, and bow lines; bight the sail snugly up together; and send it down by the clue-lines to windward or to leeward, as most convenient.

On scudding or bearing away in a storm.

When the waves run high, and sudden necessity requires to bear away, it should be considered that the lower sails forward, which the ship may be veered under when she comes before the wind, may be becalmed by the height of the waves breaking violently against the stern; and that therefore a close-reefed maintop-sail should be set to catch the wind, because it is a loftier sail, and may always be kept drawing full above the waves. This increases the ship's headway so much that the waves will not strike her abaft with so great a velocity as when her headway is less.

Hence it follows, that when going to scud before high waves, the close-reefed-main-topsail should be the last square sail taken in in a laboursome ship.

Of a ship overset on her side.

A common, but not always a certain method to recover ships from this dangerous situation, is to cut away the masts: however, as this expensive method may fail, stop-waters only, on the lee quarter at sea, may cause the ship to veer; or, where there is ground, an anchor or anchors dropped from the lee bow, may bring the wind a-head and take the sails a-back, so as to cast the ship on the other tack, and bring her upright.

To rig a main-topmast.

Tar the mast-head, get the cross-trees over, fix the bolsters and parcel them, put over burton pendants, then the shrouds, breast-back-stay, proper and spring-stay and cap, sway up the mast and fid it, seize in the dead eyes, stay the mast, set up the shrouds, rattle them down, lash the bullock blocks to the mast head.

To rig a topgallant mast.

Send down the top-rope, reeve it through the sheeve-hole, and make it fast round the hounds of the mast and standing part of the rope, leaving enough end to make fast to the cap, which done, sway-away, when the head is through the cap, make fast the spare end, or standing part of the top-rope to the cap, cut the seizing, clap on the grommet, then the shrouds, back stays and stay, sway up the mast, fid it, and set the rigging up.

To rig a bowsprit.

Lash the collar fore-stay for the bob-stays and bowsprit shrouds, then the collar for the spring stays, then the block for the topmast stay, fix the man-rope, gammon the bowsprit, and set bob-stays and shrouds up.

To rig a jib-boom.

Put over the traveller, horses, guys, the topgallant stay-block, and lash on the blocks, for the topgallant bowline and jib down-haul block to the traveller.

To rig a lower yard.

Get it athwart the gunwale, lash the jeers, quarter clue-garnets, bunt-lines, leech-lines and slab-line blocks; then put over the yard arms, the horses, brace pendants, the yard-tackle pendants, then the top-sail sheet and lift-blocks, reeve the jeers, braces, lifts and yard tackle falls, truss parcels, sway the yard up, and haul all taut.

To rig a fore-topsail yard.

Reeve a top-rope through the bullock-block and send it down, and having put over the horses, make the top-rope fast to the middle of the yard, stopping it to the yard-arm, sway it up above the top, put over the brace pendants and lift blocks, reeve the lifts and braces, cut the yard-arm seizing and cross the yard, lash the tye, bunt-line and clue-line blocks, reeve the tye and haliards, sway it up above the cap, and parcel it, reeve the clue-lines, bunt-lines and reef-tackles.

To rig a topgallant-yard.

Seize the clue-line blocks on, put the horses over the yard-arms, sway it upon the cap and rig the yard-arms, by putting on the brace-pendants and lifts, then cross the yard and parcel it.

To steer a ship when her rudder is lost.

To take a large spar, or part of a topmast, and cut it flat in the form of a stern-post, bore holes at proper distances in that part which is to be the fore part of the preventer or additional stern-post, then take the thickest plank on board, and make it as near as possible into the form of a rudder, bore holes at proper distances in the fore-part of it, and in the after part of the preventer stern post to correspond with each other: and reeve rope grammots through those holes in the rudder, and after-part of the stern-post for the rudder to play upon.

Through the preventer stern-post reeve guys, and at the fore-part of them fix tackles, and then put the machine overboard; when it is in a proper position, or in a line with the ship's stern-post, lash the upper part of the preventer post to the upper part of the ship's stern-post, then hook tackles at or near the main chains and bowse taut on the guys to confine it to the lower part of the preventer stern-post:—having holes bored through the preventer, and proper stern-post, run an iron bolt through both, taking care not to touch the rudder, which will prevent the false stern-post from rising up or falling down.

By the guys on the after part of the rudder, and tackles affixed to them, the ship may be steered, taking care to bowse taut the tackles on the preventer stern-post to keep it close to the proper stern-post.

CATALOGUE

OF THE

TABLES, WITH EXAMPLES OF THE USES OF THOSE THAT ARE NOT EXPLAINED IN OTHER PARTS OF THIS WORK.

TABLES I. and II. *Difference of Latitude and Departure.*—The first table contains the difference of latitude and departure corresponding to distances not exceeding 300, and for courses to every quarter-point of the compass. Table II. is of the same nature and extent, but for courses consisting of whole degrees. The manner of using these tables is particularly explained under the article of Inspection, in the different Problems of Plane, Middle Latitude, and Mercator's Sailing.

TABLE III. *Meridional Parts.*—An explanation of this table may be found in pages 77 and 78, and the uses of it are shown in all the Problems of Mercator's Sailing.

TABLE IV. *The Sun's Declination.*

TABLE IV. A. This table contains the *equation of time* for every noon at Greenwich and is to be reduced to any other hour by means of Table VI. A. Thus, suppose the equation of time was required for May 2, 1824, sea account at 10 A. M. apparent time, corresponding to May 1d. 22h. by the N. A. Table IV. A. gives the equation May 1, at noon, *sub.* 3m. 5s. and daily *increase* 8s. Find this at the top in Table VI. A. and 22h. at the side, the corresponding correction 7s. *increases* the equation 3m. 5s. to 3m. 12s. which is the equation at the proposed time. Thus 7s. could have been *subtractive* if the equation had been *decreasing*, as it is in March. The equation of time being thus found, *sub.* 3m. 12s. is to be subtracted from the *apparent* time 22h. as in the table to get the *mean* time 21h. 56m. 48s. If the *mean* time 21h. 56m. 48s. had been given to find the *apparent* it must be applied differently from the direction in the table, and in this example must therefore be added to 21h. 56m. 48s. to obtain the apparent time 22h.

TABLE V. *For reducing the Sun's Declination given for noon at Greenwich to any other time under any other meridian.*—The manner of using the two preceding tables is explained in pages 110 and 111.

TABLE VI. *The Sun's Right Ascension.*—The Sun's mean right ascension given in this table may be used when a Nautical Almanac cannot be procured, and no great accuracy is required. The Table is to be entered at the top with the month, and at the side with the day of the month.

TABLE VII. *Amplitudes.*—This table is explained in page 112.

TABLE VIII. *Right Ascensions and Declinations of the principal fixed Stars.*—This table contains the right ascensions and declinations of the principal fixed stars, adapted to the 1st of January, 1820, and the annual variations in right ascension and declination, by means of which the right ascensions and declinations of any of these stars may be obtained for any time before or after the year 1820, by the rule at the end of the table. To illustrate the method of doing this, we shall here give the following examples.

To find the right ascension of a star at any time.

EXAMPLE I.

Required the right ascension of Aldebaran, January 1, 1824?

	h. m. s.
R. A. by the Table in 1820	4 25 36
Variation in 4 years add	14
R. A. in January, 1824	4 25 50

EXAMPLE II.

Required the right ascension of Aldebaran, January 1, 1800?

	h. m. s.
R. A. by the Table in 1820	4 25 36
Variation in 20 years, subtract	1 9
R. A. on January 1, 1800	4 24 27

EXAMPLE III.

Required the right ascension of Spica, May 20, 1826?

	h. m. s.
R. A. by the Table in 1820	13 15 43
Variation in 6 years $4\frac{2}{3}$ months, add	20
R. A. May 20, 1826	13 16 3

EXAMPLE IV.

Required the right ascension of Sirius, November 6, 1807?

	h. m. s.
R. A. by the Table in 1820	6 37 13
Variation in 13 years subtract	34
R. A. in January, 1807	6 36 39
Variation for 10 months and 6 days, add	2
R. A. November 6, 1807	6 36 41

The sun's right ascension for any time may be found accurately by the Nautical Almanac, by taking proportional parts of the daily difference, as will be explained in the precepts of Table XXXI. But in cases where no great accuracy is required, the right ascension may be obtained within 2 or 3 minutes, by means of Table VI.

To find the declination of a Star at any time.

EXAMPLE I.

Required the declination of Aldebaran, January 1, 1824?

Declination by the Table in 1820	16° 8′ N.
Variation in 4 years 33″ add nearly	1
Declination in 1824	16 9 N.

EXAMPLE II.

Required the declination of Aldebaran, January 1, 1810?

Declination by the Table in 1820	16° 8′ N.
Variation in 10 years 1′ 20″ subtract	1
Declination January 1, 1810	16 7 N

EXAMPLE III.

Required the declination of Spica, May 20, 1826?

Declination by the Table in 1820	10° 13′ S.
Variation in 6 years 4⅔ months	2
Declination May 20, 1826	10° 15′ S.

EXAMPLE IV.

Required the declination of Sirius, November 6, 1797?

Declination by the Table in 1820	16° 29′ S.
Var. in 22 years 1 month 24 days, is sub.	2
Declination November 6, 1797	16° 27′ S.

The right ascensions and declinations obtained by the preceding calculations, are the mean values, to which must be applied the corrections for the Nutation and Aberration Tables XLII. XLIII. in cases where great accuracy is required, as is now done in the Nautical Almanac for 24 of the brightest stars for every 10 days in the year, and those numbers in the Nautical Almanac are to be preferred.

To find when a star will be on the meridian.

Rule. Find the right ascension of the sun and star in the preceding tables VI. and VIII; subtract the sun's right ascension from the star's, having previously increased the latter by 24 hours when the sun's right ascension is the greatest; the remainder will be the time of the star's coming to the meridian. If the remainder be greater than 12 hours, the star will come to the meridian after midnight; but if less than 12 hours, before midnight.

EXAMPLE I.

At what time will Aldebaran be on the meridian, January 1?

	h. m.
Aldebaran's right ascension	4 26
Add	24
	28 26
Sun's right ascension	18 45
Aldebaran souths in the evening	9 41

EXAMPLE II.

At what time will Pollux be on the meridian, March 31?

	h. m.
Pollux's right ascension	7 34
Sun's right ascension	38
Comes to the meridian in the evening	6 56

EXAMPLE III.

At what time will the star Regulus be on the meridian, December 12?

	h. m.
Regulus' right ascension	9 59
Add	24
	33 59
Sun's right ascension	17 17
After midnight	16 42
Subtract	12
In the morning	4 42

EXAMPLE IV.

Required the time when the star Fomalhaut comes on the meridian, June 1?

	h. m.
Fomalhaut's right ascension	22 48
Sun's right ascension	4 35
After midnight	18 13
Subtract	12
In the morning	6 13

To find what star will come upon the meridian at any given time.

Rule. Add the time from noon* to the right ascension of the sun, the sum (rejecting 24 hours when it exceeds 24) will be the right ascension of the star required to be known; with which enter the table of the star's right ascension, and find what star's right ascension agrees with, or comes the nearest to it, and that will be the star required, if the declination of the star agrees with the table, which may be ascertained by observing the meridian altitude of the star, the latitude of the place being given.

EXAMPLE I.

What star will be on the meridian about 10 at night, January 26?

	h. m.
Sun's right ascension January 26	20 33
Given time 10 hours P. M.	10
	30 33
Subtract	24
Nearly answers to Sirius	6 33

EXAMPLE II.

What star will be upon the meridian 30 minutes past four in the morning, May 10?

	h. m.
Sun's right ascension May 10	3 7
Given time 16 hours 30 minutes	16 30
Right ascension of mid-heaven answers nearly to Atair in the Eagle.	19 37

EXAMPLE III.

What star will be on the meridian at 6h. 53m. P. M. April 1?

	h. m.
Sun's right ascension April 1	42
Given time	6 53
Right ascension of the meridian	7 35
Answers nearly to Pollux.	

EXAMPLE IV.

What star will be on the meridian, September 1, at 5h. 37m. P. M?

	h. m.
Sun's right ascension Sept. 1	10 41
Given time	5 37
Right ascension of the meridian	16 18
Answers nearly to Antares.	

In all the preceding examples, the right ascension of the sun ought to have been calculated for the moment of the star's passing the meridian, as will be more fully explained in the precepts of Table XXXI.

* The time from noon must be reckoned from the preceding noon, so that 4h. A. M. must be called 16h.

TABLE IX. *Semi-diurnal and Semi-nocturnal arches.*—This table exhibits half the time that a celestial object continues above the horizon when the latitude and declination are of the same name, or below when they are of a contrary name; the former time being usually called the semi-diurnal arch, the latter the semi-nocturnal arch; whence the time of rising and setting may be computed, by the following rules.

To find the time of the sun's rising and setting, and the length of the day and night.

RULE. Find the sun's declination at the top of the page and the latitude in either side column, under the former, and opposite the latter, will be the time of the sun's setting if the latitude and declination are of the same name, but the time of rising if of different names.—The time of rising, subtracted from 12 hours, will give the time of setting; or the time of setting, subtracted from 12 hours, will give the time of rising.—The time of rising, being doubled, will give the length of the night; and the time of setting, being doubled, will give the length of the day.

EXAMPLE I.

Let it be required to find the time of the sun's rising and setting, with the length of the day and night in latitude 51° north, the 19th of July, 1820?

The sun's declination on the given day was 20° 51′ north, or 21° nearly, under which, and against the latitude 51°, stand 7h. 53m. the time of the sun's setting on the given day, in lat. 51° north, which doubled, gives 15h. 46m. the length of the day; and by subtracting 7h. 53m. from 12h. the remainder 4h. 7m. is the time of the sun's rising, which doubled gives 8h. 14m. the length of the night.

But, when the sun has 21° south declination in this latitude, the time of sun setting becomes 4h. 7m. the time of rising 7h. 53m. the length of the day 8h. 14m. and the length of the night 15h. 46m. as was the case nearly on the 26th November, 1820.

EXAMPLE. II.

Let it be required to find the time of the sun's rising, setting, and the length of the day and night, at Boston, the 12th of July, 1820?

	h.	m.
Under 22°, which is nearly the declination on that day, and against 42° 23′ or 42° N. the latitude of Boston, stands the time of the sun's setting	7	25
Subtracted from 12h. leaves sun-rising	4	35
Sun-setting doubled is the length of day	14	50
Sun-rising doubled is the length of night	9	10

EXAMPLE III.

Required the time of the sun's rising and setting, and length of day in latitude 31° 29′ S. May 15th, 1820?

	h.	m.
Under the declination 18° 55′ or 19° N. and against the lat. 34° S.	12	0
Stands the sun's rising	6	54
Time of sun's setting	5	6
		2
The length of the day	10	12
And 6h. 54m. doubled is length of night	13	48

When a great degree of accuracy is required, proportional parts may be taken for the minutes of latitude and declination.

To find the time of rising and setting of stars whose declination does not exceed 23° 28′.

Enter Table IX. and find the star's declination at the top, and the latitude at the side; under the former, and opposite to the latter, will be the semi-diurnal arch, when the latitude and declination are both north or both south; but if one be north and the other south, the difference between the Tabular number and 12 hours will be the semi-diurnal arch. Find the time of the star's coming to the meridian according to the precepts of Table VIII. and subtract therefrom the semi-diurnal arch, the difference will be the time of rising; or by adding together the semi-diurnal arch, and the time of passing the meridian, the time of setting will be obtained.

EXAMPLE IV.

Required when the star Arcturus rises and sets December 1, in latitude 51° N.?

	h.	m.
The time of the star's coming to the meridian, or southing in the morning, is nearly	9	38
Then under star's declination 20° nearly, and against latitude 51° stand	7	47
Time of star's rising in the morning	1	51
Added, gives the time of the star's setting	17	25
	12	
Star sets 26 minutes after 5 in the evening	5	25

EXAMPLE V.

What time will the Dog-Star Sirius rise and set at Philadelphia, Feb. 1?

	h.	m.
Under the declination, which is nearly 16° S. and against the latitude,	12	0
which is nearly 40° N. stand	6	56
Subtracted from 12h. leaves half the time the star is above the horizon	5	4
The star comes to the meridian in the evening nearly at	9	39
Sum, rejecting 12 hours, is the time of setting in the morning	2	43
Difference is the time of rising in the evening	4	35

In like manner may the rising and setting of any planet be found when the declination does not exceed 23° 28′, and the time of the passage over the meridian is known.

Suppose it was required to find the time of Jupiter's rising and setting, March 8, 1820, civil account, in the latitude of 52° N?

In the Nautical Almanac for 1820, I find that Jupiter passes the meridian March 7d. 23h. 10m. or March 8d. 11h. 10m. A. M. civil account, his declination being 10° 55′ S. or nearly 11°. Under the declination 11°, and opposite to the latitude 52° stand 6h. 58m. which is half the time Jupiter is below the horizon; this subtracted from 12h. leaves half the time that he is above the horizon, 5h. 2m.; this subtracted from 11h. 10m. A. M. leaves 6h. 8m. A. M. March 8, for the time of Jupiter's rising; and added to 11h. 10m. gives 4h. 12m. P. M. March 8, for the time of Jupiter's setting.

Suppose it was required to find the time of the moon's rising and setting, May 5, 1820, civil account, in the latitude of 52° N?

In the Nautical Almanac, page VI. I find that the moon passes the meridian May 4d. 18h. 7m. or May 5d. 6h. 7m. A. M. civil account; her declination being about 21° S. Under the declination 21°, and opposite to the latitude 52°, stand 7h. 58′, half the time the moon is below the horizon, which subtracted from 12h. leaves half the time she is above the horizon, 4h. 2m.; this subtracted from 6h. 7m. leaves 2h. 5m. A. M. the time of the moon's rising, and added to 6h. 7m. gives 10h. 9m. A. M. the time of her setting, nearly.

If greater accuracy is required, you must find the time at Greenwich corresponding to this approximate time of her rising and setting; then find the moon's declination, and the right ascensions of the sun and moon for that moment of time. The former subtracted from the latter leaves the corrected time of the moon's passing the meridian. With these data repeat the operation. In this way we may obtain the time of rising and setting to any degree of accuracy. Instead of taking the difference of the right ascension of the sun and moon, you may take the daily difference in the time of her coming to the meridian of Greenwich, and take a proportional part for the longitude of the place of observation (by means of table XXVIII.) and another proportional part, for the interval between the hour of passing the meridian, and the time of rising or setting.*

It may be noted, that the numbers of Table IX. were calculated for the moment the sun's centre appears in the true horizon; allowance ought to be made for the dip, parallax, and refraction, by which the sun and stars, when near the horizon, appear in general to be elevated above half a degree above their true place, and the moon as much below her true place.

TABLE X. *For finding the distance of any terrestrial object at sea.*—The explanation and use of this table is given in Problems VII. and VIII. pages 190, 191.

TABLE XI. *Table of Proportional Parts.*—The method of using this table is given in page 166.

TABLE XII. *Table of Refraction.*—Explained in page 108.

TABLE XIII. *Dip of the Horizon.*—Explained in page 109.

TABLE XIV. *Sun's Parallax in altitude.*—Explained in page 107.

TABLE XV. *Augmentation of the moon's semi-diameter.*—The moon's semi-diameter given in the Nautical Almanac is the same as would be seen by a spectator supposed to be placed at the centre of the earth, or nearly the same as would be seen by a spectator on the surface of the earth, when the moon is in the horizon. Now when the moon is in the zenith of the spectator placed at the surface, her distance from him is less than when at the horizon by a semi-diameter of the earth; consequently her apparent semi-diameter must be augmented in proportion as the distance is decreased, that is about one sixtieth part, or 16″. At intermediate altitudes, between the horizon and zenith, the augmentation is proportional to the sine of the altitude, and the value for every 5° or 10° of altitude is given in Table XV. The augmentation corresponding to the altitude being found in the table, must be added to the semi-diameter taken from the Nautical Almanac for the time of observation reduced to Greenwich time, as was explained in page 166.

TABLE XVI. *Dip of the sea at different distances from the observer.*—Explained in page 109.

TABLE XVII. *For finding the difference between the refraction of a star and 60′; also a log. corresponding.*

TABLE XVIII. *For finding the difference between the correction of the sun's altitude for parallax and refraction and 60′, also a logarithm corresponding thereto.*—The manner of taking the numbers from the two preceding tables is explained in page 167, and the uses to which these tables may be applied are explained in pages 167 and 174.

TABLE XIX. *For finding a correction and logarithm used in the first method of working a lunar observation.*—The correction found in this table being subtracted from 59′ 42″ will leave a remainder equal to the correction of the moon's altitude for parallax

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* In strictness, this last correction, found by the table, ought to be decreased in the ratio of 24h. to 24h. increased by the daily difference of the time of the moon's passing the meridian.

and refraction. It will be unnecessary here to point out the method of taking out this correction, as it is fully explained in the first pages of the table. It may not, however, be amiss to observe, that after constructing the logarithms of this table, it was concluded to subtract therefrom the greatest correction of the Table C corresponding, in order to render those corrections additive. Thus the logarithm corresponding to the alt. 30° and hor. par. 54′, was found at first to be 2372; and for the hor. par. 54′ 10″ the correction was 2358 so that if these numbers had been published, the correction for seconds of parallax would have been subtractive; but as this would have been inconvenient, it was thought expedient to subtract from each of the numbers thus calculated, the greatest corresponding correction of Table C, which in the preceding example is 12; by this means the above numbers were reduced to 2360 and 2346 respectively, and the corrections of Table C were rendered additive. In a similar manner the rest of the logarithms of the table were calculated. It is owing to this circumstance that the corrections in Table C for 0″ of parallax are greater than for any other number. Similar methods were used in calculating the other numbers of this table, and in arranging the Tables A and B.

TABLE XX. *Third correction of the apparent distance*—The method of finding the correction from this table is explained in pages 168, 174, 176.

TABLE XXI. *To reduce longitude into time, and the contrary.*—In the first column of this table are contained degrees and minutes of longitude, in the second the corresponding hours and minutes, or minutes and seconds of time; the other columns are a continuation of the first and second respectively. The use of this table will evidently appear by a few examples.

EXAMPLE I.

Required the time corresponding to 50° 31′?

	h. m. s.
Opposite 50° in col. 1 is	3 20 0
31′	2 4
Sought time	3 22 4

EXAMPLE II.

Required the degrees and minutes corresponding to 6h. 33m. 20s.?

Opposite 6h. 32m. 0s.		in col. 4 is	98° 0′
	1 20	in col. 2 is	20
	6 33 20		98 20

TABLE XXII. *Proportional Logarithms.*—These logarithms are very useful in finding the apparent time at Greenwich corresponding to the true distance of the moon from the sun or star, as is explained in page 168. They may be also used like common logarithms, in working any proportion where the terms are given in degrees, minutes, and seconds; or in hours, minutes, and seconds, as in the examples page 177. The table is extended only to 3° or 3h. and if any of the terms of a given proportion exceed 3° or 3h. you may take all the terms one grade lower; that is, reckon degrees as minutes, minutes as seconds, &c. and work the proportion as before; observing to write down the answer one grade higher; that is, you must estimate minutes as degrees, seconds as minutes, &c. Instead of taking all the terms one grade lower, you may change two of the terms only, viz. one of the middle terms and one of the extreme terms; thus the 1st. and 3d. or the 1st. and 2d. may be taken one grade less, and the fourth term will be given correctly; but if the fourth term be taken one grade less, you must, after working the proportion, write it one grade higher, as is evident. To illustrate this we shall give the following examples.

EXAMPLE I.

If in 15′ 10″ of time the sun rises 2° 40′ how much will it rise in 3′ 10″ at the same rate?

As	15′ 10″	Prop Log. ar. co.	8.9256
Is to	2° 40′	Prop. Log.	.0512
So is	3′ 10″	Prop. Log.	1.7547
To	33′ 24″	Prop. Log.	.7315

EXAMPLE II.

If the sun's declination changes 16′ 19″ in 24 hours, how much will it change in 8h. 2m.?

Here the 1st and 3d terms must be taken one grade less.

As	24′ 0″	P. L.	ar. co.	9.1249
Is to	16′ 19″	P. L.		1.0426
So is	8′ 2″	P. L.		1.3504
To	5′ 28″	P. L.		1.5179

EXAMPLE III.

If in 12h. the moon's longitude varies 7° 1′ what will it vary in 4h. 20m.?

Here all the terms must be taken one grade less.

As	12′ 0″	P. L.	ar. co.	8.8239
Is to	7 1	P. L.		1.4091
So is	4 20	P. L.		1.6185
To	2′ 32″ 2‴	P. L.		1.8515

Which taken one grade higher is 2° 32′ 2″ the answer required.

EXAMPLE IV.

If in 16′ the sun rises 3° 27′ how much will it rise in 3′ 10″?

Here the 2d and 4th terms must be taken one grade less.

As	16′ 0″	ar. co.	P. L.	8.9488
Is to	3 27	P. L.		1.7175
So is	3 10	P. L.		1.7547
To	0′ 41″	P. L.		2.4210

Which taken one grade higher is 41′, the answer required.

TABLES XXIII. *For finding the latitude by two altitudes of the sun.*—The manner of using this table is explained in page 139, et seq.

TABLE XXIV. *Natural Sines.*—This table contains the natural sine and co-sine for every minute of the quadrant to the radius 100000, and is to be entered at the top or bottom with the degrees, and at the side marked M. with the minutes, the corresponding numbers will be the natural sine and co-sine respectively, observing that if the degrees are found at the top, the name sine, co-sine, and M. must also be found at the top, and the contrary if the degrees are found at the bottom. Thus 43366 is the natural sine of 25° 42′ or the co-sine of 64° 18′.

TABLE XXV. *Logarithmic sines, tangents, and secants to every point and quarter point of the compass.*—This table is to be used instead of table XXVII. when the course is given in points. The course is to be found in the side column, and opposite thereto will be the log. sine, tangent, &c. The names being found at the top when the course is less than 4 points, otherwise at the bottom.

TABLE XXVI. *Logarithms of Numbers.*—The explanation and uses of this table are given in page 28, et seq.

TABLE XXVII. *Logarithmic Sines, Tangents, and Secants.*—This table is explained in page 33, et seq.

TABLE XXVIII. *For reducing the time of the Moon's passage over the meridian of Greenwich, to the time of her passage over any other meridian.*—The manner of doing this is explained in page 124.

TABLE XXIX. *Correction of the Moon's altitude for parallax and refraction.*—The mean correction of the Moon's altitude is given in this table for every degree of altitude from 10° to 90°. The manner of using this table is explained in page 126.

TABLE XXX. *For reducing the Moon's declination given in the Nautical Almanac for noon and midnight at Greenwich, to any other time under any other meridian.*—The manner of using this table is explained in page 125. In addition to which it may be observed that 12h. are marked both at the bottom of the left hand column and at the top of the right hand column; but this can cause no embarrassment, because when the time at Greenwich is 12h. the declination must be taken from the Nautical Almanac for midnight, without any correction.

TABLE XXXI. *For reducing the Sun's right ascension in time, as given in the Nautical Almanac for noon at Greenwich, to any other time under any other meridian.*—This table is useful in finding the Sun's right ascension at any time, by means of the right ascension given in the second page of the Nautical Almanac for noon at Greenwich. This table must be entered at the top with a daily variation of the sun's right ascension, and in the left hand column with the given time from noon, or in the right hand column with the longitude of the place; under the former, and opposite the latter, will stand a correction in minutes and seconds, to be applied to the sun's right ascension at noon at Greenwich. The correction found with the time from noon, is to be added in the afternoon, but subtracted in the forenoon; and the correction found with the longitude of the place, is to be added in west, but subtracted in east longitude.

Instead of finding the correction separately for the longitude of the place and the time from noon, you may find the whole correction at one entry, in the following manner: Turn the ship's longitude into time (by Tab. XXI.) and add it to the given time when in west longitude, but subtract the longitude when east; the sum or difference will be the time at Greenwich; find this time in the side column* and the daily variation at the top, corresponding to which will be the sought correction; which is to be added to the sun's right ascension for the preceding noon at Greenwich.

EXAMPLE I.

Required the sun's right ascension at noon, May 24, 1820, sea account, in the longitude of 45° W. from Greenwich?

May 24, sea account is May 23. by N. A. The sun's right ascension by N. A. at Greenw.	4h.	0m.	25s.
Corr. Tab. XXXI. for 45° long. and daily var. 4m. 2sec. add			30
Right Ascension required	4	0	55

EXAMPLE II.

Required the sun's right ascension at noon, June 24, 1820, sea account, in the longitude of 120° E. from Greenwich?

June 24, sea account is June 23, by N. A. on which day at noon the sun's right asc. was	6h.	8m.	1s.
Corr. Tab. XXXI. for 120° long. and daily variation, 4m. 9″.4 sub.		1	23
Right Ascen. required	6	6	38

EXAMPLE III.

Required the sun's right ascension, May 24, 1820, at 4h. P. M. sea account, in long. of 45° W?

R. A. at noon in long. 45° W. by Ex. I.	4h.	0m.	55s.
Corr. in Tab. XXXI. for 4h. P. M. add			40
R. A. May 24, 1820, at 4h. P. M.	4	1	35

EXAMPLE IV.

Required the sun's right ascension, June 24, 1820, at 9h. A. M. sea account, in long. of 120° E?

R. A. at noon in long. 120° E. by Ex. II.	6h.	6m.	38s.
Corr. in Tab. XXXI. for 12 hours		2	5
for 9 hours		1	34
R. A. June 24, 1808, at 9h. A. M.	6	10	17

* If the time at Greenwich be more than 12h. you must first take out the correction for 12h. and then for the rest of the time; the sum of these two will be the correction.

The third and fourth examples may be worked by a single entry of Table XXXI. as follows.

EXAMPLE III.

	d.	h.	m.
Given time by N. A. May	23	4	0
Long. 45° in time add		3	0
Time at Greenwich	23	7	0

	h.	m.	s.
Sun's R. A. May 23, at noon by N. A.	4	0	25
Corr. Tab. XXXI. for 7h.		1	11
Sun's R. A. at 4h. P. M.	4	1	36

Differing 1s. from the former method.

EXAMPLE IV.

	d.	h.	m.
Given time by N. A. June	23	21	0
Long. 120° in time		8	0
Time at Greenwich	23	13	0

	h.	m.	s.
Sun's R. A. June 23, at noon	6	8	1
Corr. Tab. XXXI. for 12h.		2	5
for 1h.			10
Sun's R. A. 21h. 0m.	6	10	16

If you wish to find accurately the time that any star comes to the meridian, or the time of rising or setting, you must take the sun's right ascension for noon at Greenwich, from the Nautical Almanac; then the star's right ascension from Table VIII. and with these, find the approximate time of rising, setting, or coming to the meridian, by the method already given in the precepts for using Tables VIII. and IX. Then calculate the sun's right ascension for this approximate time, and repeat the operation till the assumed and calculated times agree, and you will have the true time required.

To explain this method, I shall give the following examples.

To find the time when a star comes to the meridian.

EXAMPLE I.

At what time was Aldebaran on the meridian of a place in the longitude of 70° 50′ W. Jan. 2, 1820, sea account?

		h. m. s.
Jan. 2, sea account, is Jan. 1, N. A. on which day the sun's R. A. at noon at Greenwich was		18 43 48
Aldebaran's R. A.	4h. 25m. 36s.	
Add	24	
		28 25 36
Difference is the approximate time		9 41 48
Now calculating the sun's R. A. for this time in the long. of 70° 50′ W. from Greenwich, I find it was		18 46 27
Aldebaran's R. A. + 24h.		28 25 36
True time of coming to the meridian		9 39 9

EXAMPLE II.

At what time was Pollux on the meridian of a place in the longitude of 70° 46′ W. March 31, 1820, sea account?

	h. m. s.
March 31, sea account, is March 30, N. A. on which day, at noon, the sun's right ascension was	0 35 41
This, subtracted from R. A. of Pollux	7 34 17
Approximate time of southing	6 58 36
Correction of the sun's R. A. from Table XXXI. for this time is	1 4
And for the long. 70° 46′ W. of Greenw.	43
The sum of these two corrections is	1 47

which subtracted from the approximate time of southing 6h. 58m. 36s. leaves the true time 6h. 56m. 49s.

The method (used in the last example) of applying the corrections to the approximate time, instead of applying them to the right ascension of the sun, will be found the most expeditious; but it must be noted, that the corrections to be applied to the approximate time must have a contrary sign to what they would have when applied to the right ascension.

To find the time of rising or setting of a star.

Rule. Enter Table IX. with the declination of the star at the top, and the latitude of the place at the side; the corresponding number will be the time of the star's continuance above the horizon, when the latitude and declination are of the same name; but if they are of different names, the tabular number subtracted from 12h. will be the time of continuance above the horizon. Add this time to the star's right ascension, if you wish to find the time of setting; but subtract the former from the latter if you wish the time of rising. From this sum or difference subtract the sun's right ascension* corrected for the longitude of the place; the remainder will be the approximate time sought.† Enter Table XXXI. with the distance of this approximate time from noon, and the daily variation of the sun's right ascension: the correction corresponding is to be added to the approximate time in the forenoon, but subtracted in the afternoon, and you will have the corrected time of rising and setting.

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* Increasing the number from which the subtraction is to be made, by 24 hours, when necessary.

† Rejecting 24 hours when it exceeds 24 hours. If the time of rising or setting be more than 12h. it will be after midnight; but if less than 12h. it will be before midnight.

EXAMPLE I.

At what time did the star Aldebaran set, May 24, 1820, sea account, in the latitude of 38° 53′ N. and the longitude of 77° W?

The star's declination was 16° 8′ N. and the latitude 38° 53′ N. corresponding to which in Table IX. is		6h.	54m.
Star's right ascension		4	26
Sum		11	20
May 24, sea acc. or May 23 by N. A. at noon sun's R. A	4h. 0m.		
Corr. for long. 77° W.	1		
Sum subtract		4	1
Remains approximate time of setting		7	19
Corr. in Tab. XXXI. for 7h. 19m. sub.			1
Corrected time of setting, P. M.		7	18

EXAMPLE II.

At what time did the Dog-Star Sirius rise in the latitude 39° 20′ N. and the longitude of 76° 50′ W. Jan. 2, 1820, sea account?

The star's declination is 16° 28′ S. and the latitude is 39° 20′ N. corresponding to which in Table IX. is nearly		6h.	56m.
Which subtracted from		12	0
Leaves the time of the star's being above the horizon		5	4
Subtract from star's R. A.		6	37
Remainder		1	33
Add		24	
Sum		25	33
Jan. 2, sea acc. or Jan. 1, by N. A. at noon sun's R. A.	18h. 44m.		
Corr. for long. 76° 50′ W.	1		
Subtract the sum		18	45
Remains approxim. time of rising		6	48
Corr. in Tab. XXXI. for 6h. 48m. sub.			1
Corr. time of rising in the afternoon		6	47

TABLE XXXII. *Variation of the sun's altitude in one minute from noon.*

TABLE XXXIII. *To reduce the numbers of Table XXXII. to other given intervals of time from noon.*

The method of using the two preceding tables is explained in page 150 and 151.

TABLE XXXIV. *Errors arising from a deviation of 1′ in the surfaces of the central mirror.*—This table shows the error arising in measuring an angle by an instrument of reflection from a deviation of 1′ in the parallelism of the surfaces of the central mirror, the line of intersection of those surfaces (produced if necessary) being perpendicular to the plane of the instrument. If the line of intersection be inclined to that plane, the numbers in the table must, in general, be decreased in proportion to the sine of the angle of inclination.

The second, third, and fourth columns of the table are calculated upon the supposition that the surface of the horizon mirror is inclined 80° to the axis of the telescope, or that the angle intercepted between the ray incident on the horizon glass and the corresponding reflected ray passing through the telescope is 20°, which is the case in circular instruments of De Borda's construction, and on this supposition the errors of an instrument in measuring different angles may be ascertained by the rules in pages 98 and 106; when the intercepted angle is greater or less than 20°, which is the case in most sextants and quadrants, the error in any measured angle corresponding to an inclination of the surfaces of 1′, may be obtained as follows.

Find in the first column the intercepted angle, and the sum of that angle and the observed distance; take the corresponding corrections from column 5th, and their difference will be the sought correction.

In a circular instrument you must find in the side column the sum and the difference of the intercepted angle and observed angle, and take out the corresponding corrections from column 5th, half their difference will be the sought correction. Having thus found the correction corresponding to 1′, you may find the correction for other angles as in pages 98 and 106.

TABLE XXXV. *Correction for a deviation of the telescope of an instrument of reflection from the parallelism to the plane of the instrument.*—The uses of this table are explained in pages 97 and 105.

TABLE XXXVI. *Correction of the mean refraction for various heights of the barometer and thermometer.*—The use of this table is explained in page 108.

TABLE XXXVII. *Latitudes and Longitudes of the fixed Stars.*—This table contains the Latitudes and Longitudes of the principal fixed stars, adapted to the beginning of the year 1820, with the annual variations for precession and the secular equation, by which the mean values at any time may be obtained, in like manner as the Right Ascensions and declinations are from Table VIII.; by *adding* the correction of longitude *after* 1820, subtracting before 1820, and applying the correction of latitude with the same sign as in the table after 1820, but with a contrary sign before 1820.

EXAMPLE I. Required the Longitude and Latitude of α Pegasi, July 16, 1818?

Long. by Table XXXVII.	11s. 20° 58′ 44″	Latitude by Table XXXVII.	19° 24′ 44″ N.
Variation 1 year 5¼m. sub.	1′ 13″	Variation 1 year 5¼m. sub.	0
Long. July 16, 1818	11 20 57 31		19 24 44 N.

EXAMPLE II. Required the Longitude and Latitude of α Pegasi, July 1, 1822?

Long. by Table XXXVII.	11s. 20° 58′ 44″	Latitude by Table XXXVII.	19° 24′ 44″ N.
Variation 2½ years, add	2 5	Variation 2½ years, add	0
Long. July 1, 1822	11 21 0 49	Latitude July 1, 1822	19 24 44 N.

The latitudes and longitudes, thus obtained, are the mean values. When great accuracy is required, the corrections for the equation of the equinoxes, Table XL. and aberration, Table XLI. must be applied.

TABLE XXXVIII. *Reduction of latitude and horizontal parallax.*—This table contains the corrections to be subtracted from the latitude of the place of observation, and from the horizontal parallax of the Moon, given in the Nautical Almanac, in calculating eclipses of the Sun or occultations. Thus, if the latitude of the place was 40°, and the Moon's horizontal parallax 57′, the correction of latitude would be nearly—11′ 18″, and that of parallax—4″.7, so that the reduced latitude would be 39° 48′ 42″, and the reduced parallax 56′ 55″.3. These values are to be used in occultations, but in eclipses of the Sun, this parallax is to be further decreased by 8″.8 for the Sun's parallax. When the latitude is not given exactly in the table, the two nearest numbers must be found, and a proportional part of their difference is to be applied to one of the numbers, as usual. In calculating this table, the ellipticity of the earth was supposed equal to $\frac{1}{300}$, as in the third edition of La Lande's Astronomy, and in Vince's Astronomy. This value differs but little from $\frac{1}{304.6}$ and $\frac{1}{305.05}$, deduced by La Place from two lunar equations in the third volume of his immortal work, *La Mecanique Celeste*. In the second volume of the same work he calculated the ellipticity to be $\frac{1}{336}$ from the lengths of pendulums observed in different latitudes, this calculation corrected for a small mistake in the numerical coefficient of *y* in the tenth of his equations A″ becomes $\frac{1}{318}$ which does not differ very much from the value assumed in this table.

TABLE XXXIX. *Aberration of the Planets.*—This table contains the aberration of the planets, to be applied to the *true* longitude or latitude, with the *same sign* as in the table. The argument at the side is the elongation of the planet from the Sun; that is, the difference of their geocentric longitudes, or its supplement to 360°. Thus, on July 19, 1820, the longitude of the Sun was 3s. 26° 38′, the Geo. long. of Venus 4s. 13° 23′, their difference 16° 45′ is the elongation or distance from the inferior conjunction, corresponding to which is the aberration + 3″ to be applied to the true longitude given by the tables to obtain the apparent longitude. The aberration of Mercury is given at its greatest, least, and mean distances from the Sun. At the intermediate places, a proportional part of the differences of the nearest tabular numbers must be applied.

TABLES XL. & XLI. *Equation of the Equinoxes and Aberration in Longitude.*—Table XL. contains the equation of the equinoxes in longitude common to all the heavenly bodies. The argument is the longitude of the Moon's ascending node, given in page III. of the Nautical Almanac, the signs of longitude being found at the top or bottom, and the degrees at the side, the corresponding number with its sign is the equation of the equinoxes in longitude.

Table XLI. contains the aberration of the stars in longitude and latitude, to be calculated by the rules at the bottom of the tables. The signs of the argument being found at the top, and the degrees at the side,* taking proportional parts for minutes. The corrections of longitude found in these tables, are to be applied, with their signs, to the mean longitude found in Table XXXVII. and the correction of latitude, Table XLI. is to be applied to the mean latitude deduced from Table XXXVII. Thus on July 16, 1820, by the examples at the bottom of Tables XL. XLI. the equation of the equinoxes was + 1″.2 and the aberration in longitude + 11″.5, these corrections being applied to the mean longitude of the star deduced from table XXXVII. 11s. 20° 59′ 11″ gives its apparent longitude 11s. 20° 59′ 24″. In a similar manner the aberration in latitude — 5″.6, found at the bottom of Table XLI. applied to the mean latitude 19° 24′ 44″ N. deduced from Table XXXVII. gives the apparent latitude of the star 19° 24′ 38″ N.

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* The degrees in this and the following tables are to be found in the column marked D on the same horizontal line with the signs. Thus, if the signs are at the top of the table, the degrees must be found on the left column, otherwise in the right.

TABLES XLII. XLIII. *Aberration and Nutation in Right Ascension and Declination.* Table XLII. contains the aberration, and Table XLIII. the Nutation in Right Ascension and Declination, to be found by the rules at the bottom of the tables, and applied with their signs to the mean values deduced from Table VIII. Thus by Table VIII. the Right Ascension of α Pegasi, July 16. 1820, was 22h. 55′ 49″.6, and its declination 14° 14′ 10″ N. The aberration of Right Ascension in time was nearly + 0″.8, in declination — 0″.7. The Nutation in Right Ascension in time — 0″.1, in declination — 2″.2, as appears by the examples at the bottom of the tables. These corrections being applied to the mean values, give the apparent Right Ascension 22h. 55′ 50″.3, and the apparent declination 14° 14′ 7″ N. The equation of the obliquity of the ecliptic may be calculated by the rule at the bottom of the table. Thus, on July 16, 1820, the equation was + 9″.5, which applied to the mean obliquity 23° 27′ 48″.2, gives the apparent obliquity 23° 27′ 57″.7.

TABLE XLIV. *Augmentation of the Moon's Semi-diameter.*—This table is divided into four parts, and is useful in finding the augmentation of the moon's semi-diameter by means of the altitude and longitude of the nonagesimal when the moon's altitude is unknown. The precepts for this calculation are given at the bottom of the table, and for further illustration another example is added, in which it is required to find the augmentation at the commencement of the occultation calculated in Problem VII. of the Appendix, when the ☽'s S. D. by the Nautical Almanac was 16′ 18″.9, her true latitude 1° 55′ 11″ S. parallax in lat. 10′ 23″.6, altitude of the nonagesimal 81° 17′ 32″, and the moon's apparent distance from the nonagesimal 51° 38′ 26″, as in Example III. Prob. V. Appendix. In this case the arguments of Part I. are 81° 17′ 32″ + 51° 38′ 26″ or nearly 4s. 12° 56′ and 0s. 29° 39′, and the corresponding corrections + 6″.00, +4″.05, whose sum is 10″.05. This in Part II. gives +0″.10. In Part III. with the moon's true latitude 1° 55′ 11″ S. and her par. in lat. 10′ 23″.6, the correction is — 0″.10. The sum of these three parts is + 10″.05, which being found at the side of Part IV. and the moon's horizontal S. D. 16′ 18″.9 at the top, gives the corresponding correction + 0″.40. This connected with the three former parts + 10″.05, gives the sought augmentation 10″.45, or 10″.4, as in the example Prob. VII. Appendix. It may be observed that the calculation by Problem IV. will sometimes produce the supplement of the altitude of the nonagesimal, but this requires no alteration in the rule, since the result is the same whether the altitude or its supplement is used.

TABLE XLV. *Equation of Second Differences.*—This table contains the equation of the second differences of the moon's motion, or the correction to be made on account of her unequal velocity between the times marked in the Nautical Almanac. The manner of applying this correction is taught in Problems I. II. III. of the Appendix.

TABLE XLVI. *Tables of Latitudes and Longitudes.*—This table (as observed in the preface) has been completely revised for this edition, and the latitudes and longitudes of a great number of places are added to those given in the former editions of this work.

TABLE XLVII. *Tide Table.*—The explanation and uses of this table are given in page 213, et seq.

TABLE I.

Difference of Latitude and Departure for ¼ Point.

N.¼E.			N.¼W.			S.¼E.			S.¼W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	60.9	03.0	121	120.9	05.9	181	180.8	08.9	241	240.7	11.8
2	02.0	00.1	62	61.9	03.0	22	121.9	06.0	82	181.8	08.9	42	241.7	11.9
3	03.0	00.1	63	62.9	03.1	23	122.9	06.0	83	182.8	09.0	43	242.7	11.9
4	04.0	00.2	64	63.9	03.1	24	123.9	06.1	84	183.8	09.0	44	243.7	12.0
5	05.0	00.2	65	64.9	03.2	25	124.8	06.1	85	184.8	09.1	45	244.7	12.0
6	06.0	00.3	66	65.9	03.2	26	125.8	06.2	86	185.8	09.1	46	245.7	12.1
7	07.0	00.3	67	66.9	03.3	27	126.8	06.2	87	186.8	09.2	47	246.7	12.1
8	08.0	00.4	68	67.9	03.3	28	127.8	06.3	88	187.8	09.2	48	247.7	12.2
9	09.0	00.4	69	68.9	03.4	29	128.8	06.3	89	188.8	09.3	49	248.7	12.2
10	10.0	00.5	70	69.9	03.4	30	129.8	06.4	90	189.8	09.3	50	249.7	12.3
11	11.0	00.5	71	70.9	03.5	131	130.8	06.4	191	190.8	09.4	251	250.7	12.3
12	12.0	00.6	72	71.9	03.5	32	131.8	06.5	92	191.8	09.4	52	251.7	12.4
13	13.0	00.6	73	72.9	03.6	33	132.8	06.5	93	192.8	09.5	53	252.7	12.4
14	14.0	00.7	74	73.9	03.6	34	133.8	06.6	94	193.8	09.5	54	253.7	12.5
15	15.0	00.7	75	74.9	03.7	35	134.8	06.6	95	194.8	09.6	55	254.7	12.5
16	16.0	00.8	76	75.9	03.7	36	135.8	06.7	96	195.8	09.6	56	255.7	12.6
17	17.0	00.8	77	76.9	03.8	37	136.8	06.7	97	196.8	09.7	57	256.7	12.6
18	18.0	00.9	78	77.9	03.8	38	137.8	06.8	98	197.8	09.7	58	257.7	12.7
19	19.0	00.9	79	78.9	03.9	39	138.8	06.8	99	198.8	09.8	59	258.7	12.7
20	20.0	01.0	80	79.9	03.9	40	139.8	06.9	200	199.8	09.8	60	259.7	12.8
21	21.0	01.0	81	80.9	04.0	141	140.8	06.9	201	200.8	09.9	261	260.7	12.8
22	22.0	01.1	82	81.9	04.0	42	141.8	07.0	02	201.8	09.9	62	261.7	12.9
23	23.0	01.1	83	82.9	04.1	43	142.8	07.0	03	202.8	10.0	63	262.7	12.9
24	24.0	01.2	84	83.9	04.1	44	143.8	07.1	04	203.8	10.0	64	263.7	13.0
25	25.0	01.2	85	84.9	04.2	45	144.8	07.1	05	204.8	10.1	65	264.7	13.0
26	26.0	01.3	86	85.9	04.2	46	145.8	07.2	06	205.8	10.1	66	265.7	13.1
27	27.0	01.3	87	86.9	04.3	47	146.8	07.2	07	206.8	10.2	67	266.7	13.1
28	28.0	01.4	88	87.9	04.3	48	147.8	07.3	08	207.7	10.2	68	267.7	13.2
29	29.0	01.4	89	88.9	04.4	49	148.8	07.3	09	208.7	10.3	69	268.7	13.2
30	30.0	01.5	90	89.9	04.4	50	149.8	07.4	10	209.7	10.3	70	269.7	13.2
31	31.0	01.5	91	90.9	04.5	151	150.8	07.4	211	210.7	10.4	271	270.7	13.3
32	32.0	01.6	92	91.9	04.5	52	151.8	07.5	12	211.7	10.4	72	271.7	13.3
33	33.0	01.6	93	92.9	04.6	53	152.8	07.5	13	212.7	10.5	73	272.7	13.4
34	34.0	01.7	94	93.9	04.6	54	153.8	07.6	14	213.7	10.5	74	273.7	13.4
35	35.0	01.7	95	94.9	04.7	55	154.8	07.6	15	214.7	10.5	75	274.7	13.5
36	36.0	01.8	96	95.9	04.7	56	155.8	07.7	16	215.7	10.6	76	275.7	13.5
37	37.0	01.8	97	96.9	04.8	57	156.8	07.7	17	216.7	10.6	77	276.7	13.6
38	38.0	01.9	98	97.9	04.8	58	157.8	07.8	18	217.7	10.7	78	277.7	13.6
39	39.0	01.9	99	98.9	04.9	59	158.8	07.8	19	218.7	10.7	79	278.7	13.7
40	40.0	02.0	100	99.9	04.9	60	159.8	07.9	20	219.7	10.8	80	279.7	13.7
41	41.0	02.0	101	100.9	05.0	161	160.8	07.9	221	220.7	10.8	281	280.7	13.8
42	41.9	02.1	02	101.9	05.0	62	161.8	07.9	22	221.7	10.9	82	281.7	13.8
43	42.9	02.1	03	102.9	05.1	63	162.8	08.0	23	222.7	10.9	83	282.7	13.9
44	43.9	02.2	04	103.9	05.1	64	163.8	08.0	24	223.7	11.0	84	283.7	13.9
45	44.9	02.2	05	104.9	05.2	65	164.8	08.1	25	224.7	11.0	85	284.7	14.0
46	45.9	02.3	06	105.9	05.2	66	165.8	08.1	26	225.7	11.1	86	285.7	14.0
47	46.9	02.3	07	106.9	05.3	67	166.8	08.2	27	226.7	11.1	87	286.7	14.1
48	47.9	02.4	08	107.9	05.3	68	167.8	08.2	28	227.7	11.2	88	287.7	14.1
49	48.9	02.4	09	108.9	05.3	69	168.8	08.3	29	228.7	11.2	89	288.7	14.2
50	49.9	02.5	10	109.9	05.4	70	169.8	08.3	30	229.7	11.3	90	289.7	14.2
51	50.9	02.5	111	110.9	05.4	171	170.8	08.4	231	230.7	11.3	291	290.6	14.3
52	51.9	02.6	12	111.9	05.5	72	171.8	08.4	32	231.7	11.4	92	291.6	14.3
53	52.9	02.6	13	112.9	05.5	73	172.8	08.5	33	232.7	11.4	93	292.6	14.4
54	53.9	02.6	14	113.9	05.6	74	173.8	08.5	34	233.7	11.5	94	293.6	14.4
55	54.9	02.7	15	114.9	05.6	75	174.8	08.6	35	234.7	11.5	95	294.6	14.5
56	55.9	02.7	16	115.9	05.7	76	175.8	08.6	36	235.7	11.6	96	295.6	14.5
57	56.9	02.8	17	116.9	05.7	77	176.8	08.7	37	236.7	11.6	97	296.6	14.6
58	57.9	02.8	18	117.9	05.8	78	177.8	08.7	38	237.7	11.7	98	297.6	14.6
59	58.9	02.9	19	118.9	05.8	79	178.8	08.8	39	238.7	11.7	99	298.6	14.7
60	59.9	02.9	20	119.9	05.9	80	179.8	08.8	40	239.7	11.8	300	299.6	14.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.¾N.			E.¾S.			W.¾N.			W.¾S.			[For 7¾ Points.		

TABLE I.

Difference of Latitude and Departure for ½ Point.

N.½E.			N.½W.			S.½E.			S.½W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.0	121	120.4	11.9	181	180.1	17.7	241	239.8	23.6
2	02.0	00.2	62	61.7	06.1	22	121.4	12.0	82	181.1	17.8	42	240.8	23.7
3	03.0	00.3	63	62.7	06.2	23	122.4	12.1	83	182.1	17.9	43	241.8	23.8
4	04.0	00.4	64	63.7	06.3	24	123.4	12.2	84	183.1	18.0	44	242.8	23.9
5	05.0	00.5	65	64.7	06.4	25	124.4	12.3	85	184.1	18.1	45	243.8	24.0
6	06.0	00.6	66	65.7	06.5	26	125.4	12.4	86	185.1	18.2	46	244.8	24.1
7	07.0	00.7	67	66.7	06.6	27	126.4	12.4	87	186.1	18.3	47	245.8	24.2
8	08.0	00.8	68	67.7	06.7	28	127.4	12.5	88	187.1	18.4	48	246.8	24.3
9	09.0	00.9	69	68.7	06.8	29	128.4	12.6	89	188.1	18.5	49	247.8	24.4
10	10.0	01.0	70	69.7	06.9	30	129.4	12.7	90	189.1	18.6	50	248.8	24.5
11	10.9	01.1	71	70.7	07.0	131	130.4	12.8	191	190.1	18.7	251	249.8	24.6
12	11.9	01.2	72	71.7	07.1	32	131.4	12.9	92	191.1	18.8	52	250.8	24.7
13	12.9	01.3	73	72.6	07.2	33	132.4	13.0	93	192.1	18.9	53	251.8	24.8
14	13.9	01.4	74	73.6	07.3	34	133.4	13.1	94	193.1	19.0	54	252.8	24.9
15	14.9	01.5	75	74.6	07.4	35	134.3	13.2	95	194.1	19.1	55	253.8	25.0
16	15.9	01.6	76	75.6	07.4	36	135.3	13.3	96	195.1	19.2	56	254.8	25.1
17	16.9	01.7	77	76.6	07.5	37	136.3	13.4	97	196.1	19.3	57	255.8	25.2
18	17.9	01.8	78	77.6	07.6	38	137.3	13.5	98	197.0	19.4	58	256.8	25.3
19	13.9	01.9	79	78.6	07.7	39	138.3	13.6	99	198.0	19.5	59	257.8	25.4
20	19.9	02.0	80	79.6	07.8	40	139.3	13.7	200	199.0	19.6	60	258.7	25.5
21	20.9	02.1	81	80.6	07.9	141	140.3	13.8	201	200.0	19.7	261	259.7	25.6
22	21.9	02.2	82	81.6	08.0	42	141.3	13.9	02	201.0	19.8	62	260.7	25.7
23	22.9	02.3	83	82.6	08.1	43	142.3	14.0	03	202.0	19.9	63	261.7	25.8
24	23.9	02.4	84	83.6	08.2	44	143.3	14.1	04	203.0	20.0	64	262.7	25.9
25	24.9	02.5	85	84.6	08.3	45	144.3	14.2	05	204.0	20.1	65	263.7	26.0
26	25.9	02.5	86	85.6	08.4	46	145.3	14.3	06	205.0	20.2	66	264.7	26.1
27	26.9	02.6	87	86.6	08.5	47	146.3	14.4	07	206.0	20.3	67	265.7	26.2
28	27.9	02.7	83	87.6	08.6	48	147.3	14.5	08	207.0	20.4	68	266.7	26.3
29	28.9	02.8	89	88.6	08.7	49	148.3	14.6	09	208.0	20.5	69	267.7	26.4
30	29.9	02.9	90	89.6	08.8	50	149.3	14.7	10	209.0	20.6	70	268.7	26.5
31	30.9	03.0	91	90.6	08.9	151	150.3	14.8	211	210.0	20.7	271	269.7	26.6
32	31.8	03.1	92	91.6	09.0	52	151.3	14.9	12	211.0	20.8	72	270.7	26.7
33	32.8	03.2	93	92.6	09.1	53	152.3	15.0	13	212.0	20.9	73	271.7	26.8
34	33.8	03.3	94	93.5	09.2	54	153.3	15.1	14	213.0	21.0	74	272.7	26.9
35	34.8	03.4	95	94.5	09.3	55	154.3	15.2	15	214.0	21.1	75	273.7	27.0
36	35.8	03.5	96	95.5	09.4	56	155.2	15.3	16	215.0	21.2	76	274.7	27.1
37	26.8	03.6	97	96.5	09.5	57	156.2	15.4	17	216.0	21.3	77	275.7	27.2
38	37.8	03.7	98	97.5	09.6	58	157.2	15.5	18	217.0	21.4	78	276.7	27.2
39	38.8	03.8	99	98.5	09.7	59	158.2	15.6	19	217.9	21.5	79	277.7	27.3
40	39.8	03.9	100	99.5	09.8	60	159.2	15.7	20	218.9	21.6	80	278.7	27.4
41	40.8	04.0	101	100.5	09.9	161	160.2	15.8	221	219.9	21.7	281	279.6	27.5
42	41.8	04.1	02	101.5	10.0	62	161.2	15.9	22	220.9	21.8	82	280.6	27.6
43	42.8	04.2	03	102.5	10.1	63	162.2	16.0	23	221.9	21.9	83	281.6	27.7
44	43.8	04.3	04	103.5	10.2	64	163.2	16.1	24	222.9	22.0	84	282.6	27.8
45	44.8	04.4	05	104.5	10.3	65	164.2	16.2	25	223.9	22.1	85	283.6	27.9
46	45.8	04.5	06	105.5	10.4	66	165.2	16.3	26	224.9	22.2	86	284.6	28.0
47	46.8	04.6	07	106.5	10.5	67	166.2	16.4	27	225.9	22.2	87	285.6	28.1
48	47.8	04.7	03	107.5	10.6	68	167.2	16.5	28	226.9	22.3	88	286.6	28.2
49	48.8	04.8	09	108.5	10.7	69	168.2	16.6	29	227.9	22.4	89	287.6	28.3
50	49.8	04.9	10	109.5	10.8	70	169.2	16.7	30	228.9	22.5	90	288.6	28.4
51	50.8	05.0	111	110.5	10.9	171	170.2	16.8	231	229.9	22.6	291	289.6	28.5
52	51.7	05.1	12	111.5	11.0	72	171.2	16.9	32	230.9	22.7	92	290.6	28.6
53	52.7	05.2	13	112.5	11.1	73	172.2	17.0	33	231.9	22.8	93	291.6	28.7
54	53.7	05.3	14	113.5	11.2	74	173.2	17.1	34	232.9	22.9	94	292.6	28.8
55	54.7	05.4	15	114.4	11.3	75	174.2	17.2	35	233.9	23.0	95	293.6	28.9
56	55.7	05.5	16	115.4	11.4	76	175.2	17.3	36	234.9	23.1	96	294.6	29.0
57	56.7	05.6	17	116.4	11.5	77	176.1	17.3	37	235.9	23.2	97	295.6	29.1
58	57.7	05.7	18	117.4	11.6	78	177.1	17.4	38	236.9	23.3	98	296.6	29.2
59	58.7	05.8	19	118.4	11.7	79	178.1	17.5	39	237.8	23.4	99	297.6	29.3
60	59.7	05.9	20	119.4	11.8	80	179.1	17.6	40	238.8	23.5	300	298.6	29.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.½N.			E.½S.			W.½N.			W.½S.			[For 7½ Points.		

TABLE I.

Difference of Latitude and Departure for ¾ Point.

	N.¾E.			N.¾W.			S.¾E.			S.¾W.				
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.3	09.0	121	119.7	17.8	181	179.0	26.6	241	238.4	35.4
2	02.0	00.3	62	61.3	09.1	22	120.7	17.9	82	180.0	26.7	42	239.4	35.5
3	03.0	00.4	63	62.3	09.2	23	121.7	18.0	83	181.0	26.9	43	240.4	35.7
4	04.0	00.6	64	63.3	09.4	24	122.7	18.2	84	182.0	27.0	44	241.4	35.8
5	04.9	00.7	65	64.3	09.5	25	123.6	18.3	85	183.0	27.1	45	242.3	35.9
6	05.9	00.9	66	65.3	09.7	26	124.6	18.5	86	184.0	27.3	46	243.3	36.1
7	06.9	01.0	67	66.3	09.8	27	125.6	18.6	87	185.0	27.4	47	244.3	36.2
8	07.9	01.2	68	67.3	10.0	28	126.6	18.8	88	186.0	27.6	48	245.3	36.4
9	08.9	01.3	69	68.3	10.1	29	127.6	18.9	89	187.0	27.7	49	246.3	36.5
10	09.9	01.5	70	69.2	10.3	30	128.6	19.1	90	187.9	27.9	50	247.3	36.7
11	10.9	01.6	71	70.2	10.4	131	129.6	19.2	191	188.9	28.0	251	248.3	36.8
12	11.9	01.8	72	71.2	10.6	32	130.6	19.4	92	189.9	28.2	52	249.3	37.0
13	12.9	01.9	73	72.2	10.7	33	131.6	19.5	93	190.9	28.3	53	250.3	37.1
14	13.8	02.1	74	73.2	10.9	34	132.5	19.7	94	191.9	28.5	54	251.3	37.3
15	14.8	02.2	75	74.2	11.0	35	133.5	19.8	95	192.9	28.6	55	252.2	37.4
16	15.8	02.3	76	75.2	11.2	36	134.5	20.0	96	193.9	28.8	56	253.2	37.6
17	16.8	02.5	77	76.2	11.3	37	135.5	20.1	97	194.9	28.9	57	254.2	37.7
18	17.8	02.6	78	77.2	11.4	38	136.5	20.2	98	195.9	29.1	58	255.2	37.9
19	18.3	02.8	79	78.1	11.6	39	137.5	20.4	99	196.3	29.2	59	256.2	38.0
20	19.8	02.9	80	79.1	11.7	40	138.5	20.5	200	197.8	29.3	60	257,2	38.1
21	20.8	03.1	81	80.1	11.9	141	139.5	20.7	201	198.8	29.5	261	258.2	38.3
22	21.8	03.2	82	81.1	12.0	42	140.5	20.8	02	199.8	29.6	62	259.2	38.4
23	22.8	03.4	83	82.1	12.2	43	141.5	21.0	03	200.8	29.8	63	260.2	38.6
24	23.7	03.5	84	83.1	12.3	44	142.4	21.1	04	201.8	29.9	64	261.1	38.7
25	24.7	03.7	85	84.1	12.5	45	143.4	21.3	05	202.8	30.1	65	262.1	38.9
26	25.7	03.3	86	85.1	12.6	46	144.4	21.4	06	203.8	30.2	66	263.1	39.0
27	26.7	04.0	87	86.1	12.8	47	145.4	21.6	07	204.3	30.4	67	264.1	39.2
28	27.7	04.1	88	87.0	12.9	48	146.4	21.7	08	205.7	30.5	68	265.1	39.3
29	28.7	04.3	89	88.0	13.1	49	147.4	21.9	09	206.7	30.7	69	266.1	39.5
30	29.7	04.4	90	89.0	13.2	50	143.4	22.0	10	207.7	30.8	70	267.1	39.6
31	30.7	04.5	91	90.0	13.4	151	149.4	22.2	211	208.7	31.0	271	268.1	39.8
32	31.7	04.7	92	91.0	13.5	52	150.4	22.3	12	209.7	31.1	72	269.1	39.9
33	32.6	04.8	93	92.0	13.6	53	151.3	22.4	13	210.7	31.3	73	270.0	40.1
34	33.6	05.0	94	93.0	13.8	54	152.3	22.6	14	211.7	31.4	74	271.0	40.2
35	34.6	05.1	95	94.0	13.9	55	153.3	22.7	15	212.7	31.5	75	272.0	40.4
36	35.6	05.3	96	95.0	14.1	56	154.3	22.9	16	213.7	31.7	76	273.0	40.5
37	36.6	05.4	97	96.0	14.2	57	155.3	23.0	17	214.7	31.8	77	274.0	40.6
38	37.6	05.6	98	96.9	14.4	58	156.3	23.2	18	215.6	32.0	78	275.0	40.8
39	38.6	05.7	99	97.9	14.5	59	157.3	23.3	19	216.6	32.1	79	276.0	40.9
40	39.6	05.9	100	98.9	14.7	60	158.3	23.5	20	217.6	32.3	80	277.0	41.1
41	40.6	06.0	101	99.9	14.8	161	159.3	23.6	221	218.6	32.4	281	278.0	41.2
42	41.5	06.2	02	100.9	15.0	62	160.2	23.8	22	219.6	32.6	82	278.9	41.4
43	42.5	06.3	03	101.9	15.1	63	161.2	23.9	23	220.6	32.7	83	279.9	41.5
44	43.5	06.5	04	102.9	15.3	64	162.2	24.1	24	221.6	32.9	84	280.9	41.7
45	44.5	06.6	05	103.9	15.4	65	163.2	24.2	25	222.6	33.0	85	281.9	41.8
46	45.5	06.7	06	104.9	15.6	66	164.2	24.4	26	223.6	33.2	86	282.9	42.0
47	46.5	06.9	07	105.8	15.7	67	165.2	24.5	27	224.5	33.3	87	283.9	42.1
48	47.5	07.0	08	106.8	15.8	68	166.2	24.7	28	225.5	33.5	88	284.9	42.3
49	48.5	07.2	09	107.8	16.0	69	167.2	24.8	29	226.5	33.6	89	285.9	42.4
50	49.5	07.3	10	108.8	16.1	70	168.2	24.9	30	227.5	33.7	90	286.9	42.6
51	50.4	07.5	111	109.8	16.3	171	169.1	25.1	231	228.5	33.9	291	287.9	42.7
52	51.4	07.6	12	110.8	16.4	72	170.1	25.2	32	229.5	34.0	92	283.8	42.8
53	52.4	07.8	13	111.8	16.6	73	171.1	25.4	33	230.5	34.2	93	289.8	43.0
54	53.4	07.9	14	112.8	16.7	74	172.1	25.5	34	231.5	34.3	94	290.8	43.1
55	54.4	08.1	15	113.8	16.9	75	173.1	25.7	35	232.5	34.5	95	291.8	43.3
56	55.4	08.2	16	114.7	17.0	76	174.1	25.8	36	233.4	34.6	96	292.8	43.4
57	56.4	08.4	17	115.7	17.2	77	175.1	26.0	37	234.4	34.8	97	293.8	43.6
58	57.4	08.5	18	116.7	17.3	78	176.1	26.1	38	235.4	34.9	98	294.3	43.7
59	58.4	08.7	19	117.7	17.5	79	177.1	26.3	39	236.4	35.1	99	295.8	43.9
60	59.4	08.8	20	118.7	17.6	80	178.1	26.4	40	237.4	35.2	300	296.8	44.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
	E.¾N.			E.¾S.			W.¾N.			W.¾S.			[For 7¼ Points.	

TABLE I.

Difference of Latitude and Departure for 1 Point.

N.b.E.			N.b.W.			S.b.E.			S.b.W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.8	11.9	121	118.7	23.6	181	177.5	35.3	241	236.4	47.0
2	02.0	00.4	62	60.8	12.1	22	119.7	23.8	82	178.5	35.5	42	237.4	47.2
3	02.9	00.6	63	61.8	12.3	23	120.6	24.0	83	179.5	35.7	43	238.3	47.4
4	03.9	00.8	64	62.8	12.5	24	121.6	24.2	84	180.5	35.9	44	239.3	47.6
5	04.9	01.0	65	63.8	12.7	25	122.6	24.4	85	181.4	36.1	45	240.3	47.8
6	05.9	01.2	66	64.7	12.9	26	123.6	24.6	86	182.4	36.3	46	241.3	48.0
7	06.9	01.4	67	65.7	13.1	27	124.6	24.8	87	183.4	36.5	47	242.3	48.2
8	07.8	01.6	68	66.7	13.3	28	125.5	25.0	88	184.4	36.7	48	243.2	48.4
9	08.8	01.8	69	67.7	13.5	29	126.5	25.2	89	185.4	36.9	49	244.2	48.6
10	09.8	02.0	70	68.7	13.7	30	127.5	25.4	90	186.3	37.1	50	245.2	48.8
11	10.8	02.1	71	69.6	13.9	131	128.5	25.6	191	187.3	37.3	251	246.2	49.0
12	11.8	02.3	72	70.6	14.0	32	129.5	25.8	92	188.3	37.5	52	247.2	49.2
13	12.8	02.5	73	71.6	14.2	33	130.4	25.9	93	189.3	37.7	53	248.1	49.4
14	13.7	02.7	74	72.6	14.4	34	131.4	26.1	94	190.3	37.8	54	249.1	49.6
15	14.7	02.9	75	73.6	14.6	35	132.4	26.3	95	191.3	38.0	55	250.1	49.7
16	15.7	03.1	76	74.5	14.8	36	133.4	26.5	96	192.2	38.2	56	251.1	49.9
17	16.7	03.3	77	75.5	15.0	37	134.4	26.7	97	193.2	38.4	57	252.1	50.1
18	17.7	03.5	78	76.5	15.2	38	135.3	26.9	98	194.2	38.6	58	253.0	50.3
19	18.6	03.7	79	77.5	15.4	39	136.3	27.1	99	195.2	38.8	59	254.0	50.5
20	19.6	03.9	80	78.5	15.6	40	137.3	27.3	200	196.2	39.0	60	255.0	50.7
21	20.6	04.1	81	79.4	15.8	141	138.3	27.5	201	197.1	39.2	261	256.0	50.9
22	21.6	04.3	82	80.4	16.0	42	139.3	27.7	02	198.1	39.4	62	257.0	51.1
23	22.6	04.5	83	81.4	16.2	43	140.3	27.9	03	199.1	39.6	63	257.9	51.3
24	23.5	04.7	84	82.4	16.4	44	141.2	28.1	04	200.1	39.8	64	258.9	51.5
25	24.5	04.9	85	83.4	16.6	45	142.2	28.3	05	201.1	40.0	65	259.9	51.7
26	25.5	05.1	86	84.3	16.8	46	143.2	28.5	06	202.0	40.2	66	260.9	51.9
27	26.5	05.3	87	85.3	17.0	47	144.2	28.7	07	203.0	40.4	67	261.9	52.1
28	27.5	05.5	88	86.3	17.2	48	145.2	28.9	08	204.0	40.6	68	262.9	52.3
29	28.4	05.7	89	87.3	17.4	49	146.1	29.1	09	205.0	40.8	69	263.8	52.5
30	29.4	05.9	90	88.3	17.6	50	147.1	29.3	10	206.0	41.0	70	264.8	52.7
31	30.4	06.0	91	89.3	17.8	151	148.1	29.5	211	206.9	41.2	271	265.8	52.9
32	31.4	06.2	92	90.2	17.9	52	149.1	29.7	12	207.9	41.4	72	266.8	53.1
33	32.4	06.4	93	91.2	18.1	53	150.1	29.8	13	208.9	41.6	73	267.8	53.3
34	33.3	06.6	94	92.2	18.3	54	151.0	30.0	14	209.9	41.7	74	268.7	53.5
35	34.3	06.8	95	93.2	18.5	55	152.0	30.2	15	210.9	41.9	75	269.7	53.6
36	35.3	07.0	96	94.2	18.7	56	153.0	30.4	16	211.8	42.1	76	270.7	53.8
37	36.3	07.2	97	95.1	18.9	57	154.0	30.6	17	212.8	42.3	77	271.7	54.0
38	37.3	07.4	98	96.1	19.1	58	155.0	30.8	18	213.8	42.5	78	272.7	54.2
39	38.3	07.6	99	97.1	19.3	59	155.9	31.0	19	214.8	42.7	79	273.6	54.4
40	39.2	07.8	100	98.1	19.5	60	156.9	31.2	20	215.8	42.9	80	274.6	54.6
41	40.2	08.0	101	99.1	19.7	161	157.9	31.4	221	216.8	43.1	281	275.6	54.8
42	41.2	08.2	02	100.0	19.9	62	158.9	31.6	22	217.7	43.3	82	276.6	55.0
43	42.2	08.4	03	101.0	20.1	63	159.9	31.8	23	218.7	43.5	83	277.6	55.2
44	43.2	08.6	04	102.0	20.3	64	160.8	32.0	24	219.7	43.7	84	278.5	55.4
45	44.1	08.8	05	103.0	20.5	65	161.8	32.2	25	220.7	43.9	85	279.5	55.6
46	45.1	09.0	06	104.0	20.7	66	162.8	32.4	26	221.7	44.1	86	280.5	55.8
47	46.1	09.2	07	104.9	20.9	67	163.8	32.6	27	222.6	44.3	87	281.5	56.0
48	47.1	09.4	08	105.9	21.1	68	164.8	32.8	28	223.6	44.5	88	282.5	56.2
49	48.1	09.6	09	106.9	21.3	69	165.8	33.0	29	224.6	44.7	89	283.4	56.4
50	49.0	09.8	10	107.9	21.5	70	166.7	33.2	30	225.6	44.9	90	284.4	56.6
51	50.0	09.9	111	108.9	21.7	171	167.7	33.4	231	226.6	45.1	291	285.4	56.8
52	51.0	10.1	12	109.8	21.9	72	168.7	33.6	32	227.5	45.3	92	286.4	57.0
53	52.0	10.3	13	110.8	22.0	73	169.7	33.8	33	228.5	45.5	93	287.4	57.2
54	53.0	10.5	14	111.8	22.2	74	170.7	33.9	34	229.5	45.7	94	288.4	57.4
55	53.9	10.7	15	112.8	22.4	75	171.6	34.1	35	230.5	45.8	95	289.3	57.6
56	54.9	10.9	16	113.8	22.6	76	172.6	34.3	36	231.5	46.0	96	290.3	57.7
57	55.9	11.1	17	114.8	22.8	77	173.6	34.5	37	232.4	46.2	97	291.3	57.9
58	56.9	11.3	18	115.7	23.0	78	174.6	34.7	38	233.4	46.4	98	292.3	58.1
59	57.9	11.5	19	116.7	23.2	79	175.6	34.9	39	234.4	46.6	99	293.3	58.3
60	58.8	11.7	20	117.7	23.4	80	176.5	35.1	40	235.4	46.8	300	294.2	58.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.b.N.			E.b.S.			W.b.N.			W.b.S.					

[For 7 Points.

Difference of Latitude and Departure for 1¼ Points.

N.b.E.¼E.			N.b.W.¼W.			S.b.E.¼E.			S.b.W.¼W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.2	14.8	121	117.4	29.4	181	175.6	44.0	241	233.8	58.6
2	01.9	00.5	62	60.1	15.1	22	118.3	29.6	82	176.5	44.2	42	234.7	58.8
3	02.9	00.7	63	61.1	15.3	23	119.3	29.9	83	177.5	44.5	43	235.7	59.0
4	03.9	01.0	64	62.1	15.6	24	120.3	30.1	84	178.5	44.7	44	236.7	59.3
5	04.9	01.2	65	63.1	15.8	25	121.3	30.4	85	179.5	45.0	45	237.7	59.5
6	05.8	01.5	66	64.0	16.0	26	122.2	30.6	86	180.4	45.2	46	238.6	59.8
7	06.8	01.7	67	65.0	16.3	27	123.2	30.9	87	181.4	45.4	47	239.6	60.0
8	07.8	01.9	68	66.0	16.5	28	124.2	31.1	88	182.4	45.7	48	240.6	60.3
9	08.7	02.2	69	66.9	16.8	29	125.1	31.3	89	183.3	45.9	49	241.5	60.5
10	09.7	02.4	70	67.9	17.0	30	126.1	31.6	90	184.3	46.2	50	242.5	60.7
11	10.7	02.7	71	68.9	17.3	131	127.1	31.8	191	185.3	46.4	251	243.5	61.0
12	11.6	02.9	72	69.8	17.5	32	128.0	32.1	92	186.2	46.7	52	244.4	61.2
13	12.6	03.2	73	70.8	17.7	33	129.0	32.3	93	187.2	46.9	53	245.4	61.5
14	13.6	03.4	74	71.8	18.0	34	130.0	32.6	94	188.2	47.1	54	246.4	61.7
15	14.6	03.6	75	72.8	18.2	35	131.0	32.8	95	189.2	47.4	55	247.4	62.0
16	15.5	03.9	76	73.7	18.5	36	131.9	33.0	96	190.1	47.6	56	248.3	62.2
17	16.5	04.1	77	74.7	18.7	37	132.9	33.3	97	191.1	47.9	57	249.3	62.4
18	17.5	04.4	78	75.7	19.0	38	133.9	33.5	98	192.1	48.1	58	250.3	62.7
19	18.4	04.6	79	76.6	19.2	39	134.8	33.8	99	193.0	48.4	59	251.2	62.9
20	19.4	04.9	80	77.6	19.4	40	135.8	34.0	200	194.0	48.6	60	252.2	63.2
21	20.4	05.1	81	78.6	19.7	141	136.8	34.3	201	195.0	48.8	261	253.2	63.4
22	21.3	05.3	82	79.5	19.9	42	137.7	34.5	02	195.9	49.1	62	254.1	63.7
23	22.3	05.6	83	80.5	20.2	43	138.7	34.7	03	196.9	49.3	63	255.1	63.9
24	23.3	05.8	84	81.5	20.4	44	139.7	35.0	04	197.9	49.6	64	256.1	64.1
25	24.3	06.1	85	82.5	20.7	45	140.7	35.2	05	198.9	49.8	65	257.1	64.4
26	25.2	06.3	86	83.4	20.9	46	141.6	35.5	06	199.8	50.1	66	258.0	64.6
27	26.2	06.6	87	84.4	21.1	47	142.6	35.7	07	200.8	50.3	67	259.0	64.9
28	27.2	06.8	88	85.4	21.4	48	143.6	36.0	08	201.8	50.5	68	260.0	65.1
29	28.1	07.0	89	86.3	21.6	49	144.5	36.2	09	202.7	50.8	69	260.9	65.4
30	29.1	07.3	90	87.3	21.9	50	145.5	36.4	10	203.7	51.0	70	261.9	65.6
31	30.1	07.5	91	88.3	22.1	151	146.5	36.7	211	204.7	51.3	271	262.9	65.8
32	31.0	07.8	92	89.2	22.4	52	147.4	36.9	12	205.6	51.5	72	263.8	66.1
33	32.0	08.0	93	90.2	22.6	53	148.4	37.2	13	206.6	51.8	73	264.8	66.3
34	33.0	08.3	94	91.2	22.8	54	149.4	37.4	14	207.6	52.0	74	265.8	66.6
35	34.0	08.5	95	92.2	23.1	55	150.4	37.7	15	208.6	52.2	75	266.8	66.8
36	34.9	08.7	96	93.1	23.3	56	151.3	37.9	16	209.5	52.5	76	267.7	67.1
37	35.9	09.0	97	94.1	23.6	57	152.3	38.1	17	210.5	52.7	77	268.7	67.3
38	36.9	09.2	98	95.1	23.8	58	153.3	38.4	18	211.5	53.0	78	269.7	67.5
39	37.8	09.5	99	96.0	24.1	59	154.2	38.6	19	212.4	53.2	79	270.6	67.8
40	38.8	09.7	100	97.0	24.3	60	155.2	38.9	20	213.4	53.5	80	271.6	68.0
41	39.8	10.0	101	98.0	24.5	161	156.2	39.1	221	214.4	53.7	281	272.6	68.3
42	40.7	10.2	02	98.9	24.8	62	157.1	39.4	22	215.3	53.9	82	273.5	68.5
43	41.7	10.4	03	99.9	25.0	63	158.1	39.6	23	216.3	54.2	83	274.5	68.8
44	42.7	10.7	04	100.9	25.3	64	159.1	39.8	24	217.3	54.4	84	275.5	69.0
45	43.7	10.9	05	101.9	25.5	65	160.1	40.1	25	218.3	54.7	85	276.5	69.2
46	44.6	11.2	06	102.8	25.8	66	161.0	40.3	26	219.2	54.9	86	277.4	69.5
47	45.6	11.4	07	103.8	26.0	67	162.0	40.6	27	220.2	55.2	87	278.4	69.7
48	46.6	11.7	08	104.8	26.2	68	163.0	40.8	28	221.2	55.4	88	279.4	70.0
49	47.5	11.9	09	105.7	26.5	69	163.9	41.1	29	222.1	55.6	89	280.3	70.2
50	48.5	12.1	10	106.7	26.7	70	164.9	41.3	30	223.1	55.9	90	281.3	70.5
51	49.5	12.4	111	107.7	27.0	171	165.9	41.5	231	224.1	56.1	291	282.3	70.7
52	50.4	12.6	12	108.6	27.2	72	166.8	41.8	32	225.0	56.4	92	283.2	71.0
53	51.4	12.9	13	109.6	27.5	73	167.8	42.0	33	226.0	56.6	93	284.2	71.2
54	52.4	13.1	14	110.6	27.7	74	168.8	42.3	34	227.0	56.9	94	285.2	71.4
55	53.4	13.4	15	111.6	27.9	75	169.8	42.5	35	228.0	57.1	95	286.2	71.7
56	54.3	13.6	16	112.5	28.2	76	170.7	42.8	36	228.9	57.3	96	287.1	71.9
57	55.3	13.8	17	113.5	28.4	77	171.7	43.0	37	229.9	57.6	97	288.1	72.2
58	56.3	14.1	18	114.5	28.7	78	172.7	43.3	38	230.9	57.8	98	289.1	72.4
59	57.2	14.3	19	115.4	28.9	79	173.6	43.5	39	231.8	58.1	99	290.0	72.7
60	58.2	14.6	20	116.4	29.2	80	174.6	43.7	40	232.8	58.3	300	291.0	72.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.N.E.¾E.			E.S.E.¾E.			W.N.W.¾W.			W.S.W.¾W.			[For 6¾ Points.		

TABLE I.

Difference of Latitude and Departure for 1½ Points.

N.b.E.½E.			N.b.W.½W.			S.b.E.½E.			S.b.W.½W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.4	17.7	121	115.8	35.1	181	173.2	52.5	241	230.6	70.0
2	01.9	00.6	62	59.3	18.0	22	116.7	35.4	82	174.2	52.8	42	231.6	70.2
3	02.9	00.9	63	60.3	18.3	23	117.7	35.7	83	175.1	53.1	43	232.5	70.5
4	03.8	01.2	64	61.2	18.6	24	118.7	36.0	84	176.1	53.4	44	233.5	70.8
5	04.8	01.5	65	62.2	18.9	25	119.6	36.3	85	177.0	53.7	45	234.5	71.1
6	05.7	01.7	66	63.2	19.2	26	120.6	36.6	86	178.0	54.0	46	235.4	71.4
7	06.7	02.0	67	64.1	19.4	27	121.5	36.9	87	178.9	54.3	47	236.4	71.7
8	07.7	02.3	68	65.1	19.7	28	122.5	37.2	88	179.9	54.6	48	237.3	72.0
9	08.6	02.6	69	66.0	20.0	29	123.4	37.4	89	180.9	54.9	49	238.3	72.3
10	09.6	02.9	70	67.0	20.3	30	124.4	37.7	90	181.8	55.2	50	239.2	72.6
11	10.5	03.2	71	67.9	20.6	131	125.4	38.0	191	182.8	55.4	251	240.2	72.9
12	11.5	03.5	72	68.9	20.9	32	126.3	38.3	92	183.7	55.7	52	241.1	73.2
13	12.4	03.8	73	69.9	21.2	33	127.3	38.6	93	184.7	56.0	53	242.1	73.4
14	13.4	04.1	74	70.8	21.5	34	128.2	38.9	94	185.6	56.3	54	243.1	73.7
15	14.4	04.4	75	71.8	21.8	35	129.2	39.2	95	186.6	56.6	55	244.0	74.0
16	15.3	04.6	76	72.7	22.1	36	130.1	39.5	96	187.6	56.9	56	245.0	74.3
17	16.3	04.9	77	73.7	22.4	37	131.1	39.8	97	188.5	57.2	57	245.9	74.6
18	17.2	05.2	78	74.6	22.6	38	132.1	40.1	98	189.5	57.5	58	246.9	74.9
19	18.2	05.5	79	75.6	22.9	39	133.0	40.3	99	190.4	57.8	59	247.8	75.2
20	19.1	05.8	80	76.6	23.2	40	134.0	40.6	200	191.4	58.1	60	248.8	75.5
21	20.1	06.1	81	77.5	23.5	141	134.9	40.9	201	192.3	58.3	261	249.8	75.8
22	21.1	06.4	82	78.5	23.8	42	135.9	41.2	02	193.3	58.6	62	250.7	76.1
23	22.0	06.7	83	79.4	24.1	43	136.8	41.5	03	194.3	58.9	63	251.7	76.3
24	23.0	07.0	84	80.4	24.4	44	137.8	41.8	04	195.2	59.2	64	252.6	76.6
25	23.9	07.3	85	81.3	24.7	45	138.8	42.1	05	196.2	59.5	65	253.6	76.9
26	24.9	07.5	86	82.3	25.0	46	139.7	42.4	06	197.1	59.8	66	254.5	77.2
27	25.8	07.8	87	83.3	25.3	47	140.7	42.7	07	198.1	60.1	67	255.5	77.5
28	26.8	08.1	88	84.2	25.5	48	141.6	43.0	08	199.0	60.4	68	256.5	77.8
29	27.8	08.4	89	85.2	25.8	49	142.6	43.3	09	200.0	60.7	69	257.4	78.1
30	28.7	08.7	90	86.1	26.1	50	143.5	43.5	10	201.0	61.0	70	258.4	78.4
31	29.7	09.0	91	87.1	26.4	151	144.5	43.8	211	201.9	61.3	271	259.3	78.7
32	30.6	09.3	92	88.0	26.7	52	145.5	44.1	12	202.9	61.5	72	260.3	79.0
33	31.6	09.6	93	89.0	27.0	53	146.4	44.4	13	203.8	61.8	73	261.2	79.2
34	32.5	09.9	94	90.0	27.3	54	147.4	44.7	14	204.8	62.1	74	262.2	79.5
35	33.5	10.2	95	90.9	27.6	55	148.3	45.0	15	205.7	62.4	75	263.2	79.8
36	34.4	10.5	96	91.9	27.9	56	149.3	45.3	16	206.7	62.7	76	264.1	80 1
37	35.4	10.7	97	92.8	28.2	57	150.2	45.6	17	207.7	63.0	77	265.1	80.4
38	36.4	11.0	98	93.8	28.4	58	151.2	45.9	18	208.6	63.3	78	266.0	80.7
39	37.3	11.3	99	94.7	28.7	59	152.2	46.2	19	209.6	63.6	79	267.0	81.0
40	38.3	11.6	100	95.7	29.0	60	153.1	46.4	20	210.5	63.9	80	267.9	81.3
41	39.2	11.9	101	96.7	29.3	161	154.1	46.7	221	211.5	64.2	281	268.9	81.6
42	40.2	12.2	02	97.6	29.6	62	155.0	47.0	22	212.4	64.4	82	269.9	81.9
43	41.1	12.5	03	98.6	29.9	63	156.0	47.3	23	213.4	64.7	83	270.8	82.2
44	42.1	12.8	04	99.5	30.2	64	156.9	47.6	24	214.4	65.0	84	271.8	82.4
45	43.1	13.1	05	100.5	30.5	65	157.9	47.9	25	215.3	65.3	85	272.7	82.7
46	44.0	13.4	06	101.4	30.8	66	158.9	48.2	26	216.3	65.6	86	273.7	83.0
47	45.0	13.6	07	102.4	31.1	67	159.8	48.5	27	217.2	65.9	87	274.6	83.3
48	45.9	13.9	08	103.3	31.4	68	160.8	48.8	28	218.2	66.2	88	275.6	83.6
49	46.9	14.2	09	104.3	31.6	69	161.7	49.1	29	219.1	66.5	89	276.6	83.9
50	47.8	14.5	10	105.3	31.9	70	162.7	49.3	30	220.1	66.8	90	277.5	84.2
51	48.8	14.8	111	106.2	32.2	171	163.6	49.6	231	221.1	67.1	291	278.5	84.5
52	49.8	15.1	12	107.2	32.5	72	164.6	49.9	32	222.0	67.3	92	279.4	84.8
53	50.7	15.4	13	108.1	32.8	73	165.6	50.2	33	223.0	67.6	93	280.4	85.1
54	51.7	15.7	14	109.1	33.1	74	166.5	50.5	34	223.9	67.9	94	281.3	85.3
55	52.6	16.0	15	110.0	33.4	75	167.5	50.8	35	224.9	68.2	95	282.3	85.6
56	53.6	16.3	16	111.0	33.7	76	168.4	51.1	36	225.8	68.5	96	283.3	85.9
57	54.5	16.5	17	112.0	34.0	77	169.4	51.4	37	226.8	68.8	97	284.2	86.2
58	55.5	16.8	18	112.9	34.3	78	170.3	51.7	38	227.8	69.1	98	285.2	86.5
59	56.5	17.1	19	113.9	34.5	79	171.3	52.0	39	228.7	69.4	99	286.1	86.8
60	57.4	17.4	20	114.8	34.8	80	172.2	52.3	40	229.7	69.7	300	287.1	87.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.N.E.½E.			E.S.E.½E.			W.N.W.½W.			W.S.W.½W.			[For 6½ Points.		

Difference of Latitude and Departure for 1¾ Points.

N.b.E.¾E.			N.b.W.¾W.			S.b.E.¾E.			S.b.W.¾W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.4	20.6	121	113.9	40.8	181	170.4	61.0	241	226.9	81.2
2	01.9	00.7	62	58.4	20.9	22	114.9	41.1	82	171.4	61.3	42	227.9	81.5
3	02.8	01.0	63	59.3	21.2	23	115.8	41.4	83	172.3	61.7	43	228.8	81.9
4	03.8	01.3	64	60.3	21.6	24	116.8	41.8	84	173.2	62.0	44	229.7	82.2
5	04.7	01.7	65	61.2	21.9	25	117.7	42.1	85	174.2	62.3	45	230.7	82.5
6	05.6	02.0	66	62.1	22.2	26	118.6	42.4	86	175.1	62.7	46	231.6	82.9
7	06.6	02.4	67	63.1	22.6	27	119.6	42.8	87	176.1	63.0	47	232.6	83.2
8	07.5	02.7	68	64.0	22.9	28	120.5	43.1	88	177.0	63.3	48	233.5	83.5
9	08.5	03.0	69	65.0	23.2	29	121.5	43.5	89	178.0	63.7	49	234.4	83.9
10	09.4	03.4	70	65.9	23.6	30	122.4	43.8	90	178.9	64.0	50	235.4	84.2
11	10.4	03.7	71	66.8	23.9	131	123.3	44.1	191	179.8	64.3	251	236.3	84.6
12	11.3	04.0	72	67.8	24.3	32	124.3	44.5	92	180.8	64.7	52	237.3	84.9
13	12.2	04.4	73	68.7	24.6	33	125.2	44.8	93	181.7	65.0	53	238.2	85.2
14	13.2	04.7	74	69.7	24.9	34	126.2	45.1	94	182.7	65.4	54	239.2	85.6
15	14.1	05.1	75	70.6	25.3	35	127.1	45.5	95	183.6	65.7	55	240.1	85.9
16	15.1	05.4	76	71.6	25.6	36	128.0	45.8	96	184.5	66.0	56	241.0	86.2
17	16.0	05.7	77	72.5	25.9	37	129.0	46.2	97	185.5	66.4	57	242.0	86.6
18	16.9	06.1	78	73.4	26.3	38	129.9	46.5	98	186.4	66.7	58	242.9	86.9
19	17.9	06.4	79	74.4	26.6	39	130.9	46.8	99	187.4	67.0	59	243.9	87.3
20	18.8	06.7	80	75.3	27.0	40	131.8	47.2	200	188.3	67.4	60	244.8	87.6
21	19.8	07.1	81	76.3	27.3	141	132.8	47.5	201	189.3	67.7	261	245.7	87.9
22	20.7	07.4	82	77.2	27.6	42	133.7	47.8	02	190.2	68.1	62	246.7	88.3
23	21.7	07.7	83	78.1	28.0	43	134.6	48.2	03	191.1	68.4	63	247.6	88.6
24	22.6	08.1	84	79.1	28.3	44	135.6	48.5	04	192.1	68.7	64	248.6	88.9
25	23.5	08.4	85	80.0	28.6	45	136.5	48.8	05	193.0	69.1	65	249.5	89.3
26	24.5	08.8	86	81.0	29.0	46	137.5	49.2	06	194.0	69.4	66	250.5	89.6
27	25.4	09.1	87	81.9	29.3	47	138.4	49.5	07	194.9	69.7	67	251.4	89.9
28	26.4	09.4	88	82.9	29.6	48	139.3	49.9	08	195.8	70.1	68	252.3	90.3
29	27.3	09.8	89	83.8	30.0	49	140.3	50.2	09	196.8	70.4	69	253.3	90.6
30	28.2	10.1	90	84.7	30.3	50	141.2	50.5	10	197.7	70.7	70	254.2	91.0
31	29.2	10.4	91	85.7	30.7	151	142.2	50.9	211	198.7	71.1	271	255.2	91.3
32	30.1	10.8	92	86.6	31.0	52	143.1	51.2	12	199.6	71.4	72	256.1	91.6
33	31.1	11.1	93	87.6	31.3	53	144.1	51.5	13	200.5	71.8	73	257.0	92.0
34	32.0	11.5	94	88.5	31.7	54	145.0	51.9	14	201.5	72.1	74	258.0	92.3
35	33.0	11.8	95	89.4	32.0	55	145.9	52.2	15	202.4	72.4	75	258.9	92.6
36	33.9	12.1	96	90.4	32.3	56	146.9	52.6	16	203.4	72.8	76	259.9	93.0
37	34.8	12.5	97	91.3	32.7	57	147.8	52.9	17	204.3	73.1	77	260.8	93.3
38	35.8	12.8	98	92.3	33.0	58	148.8	53.2	18	205.3	73.4	78	261.7	93.7
39	36.7	13.1	99	93.2	33.4	59	149.7	53.6	19	206.2	73.8	79	262.7	94.0
40	37.7	13.5	100	94.2	33.7	60	150.6	53.9	20	207.1	74.1	80	263.6	94.3
41	38.6	13.8	101	95.1	34.0	161	151.6	54.2	221	208.1	74.5	281	264.6	94.7
42	39.5	14.1	02	96.0	34.4	62	152.5	54.6	22	209.0	74.8	82	265.5	95.0
43	40.5	14.5	03	97.0	34.7	63	153.5	54.9	23	210.0	75.1	83	266.5	95.3
44	41.4	14.8	04	97.9	35.0	64	154.4	55.2	24	210.9	75.5	84	267.4	95.7
45	42.4	15.2	05	98.9	35.4	65	155.4	55.6	25	211.8	75.8	85	268.3	96.0
46	43.3	15.5	06	99.8	35.7	66	156.3	55.9	26	212.8	76.1	86	269.3	96.4
47	44.3	15.8	07	100.7	36.0	67	157.2	56.3	27	213.7	76.5	87	270.2	96.7
48	45.2	16.2	08	101.7	36.4	68	158.2	56.6	28	214.7	76.8	88	271.2	97.0
49	46.1	16.5	09	102.6	36.7	69	159.1	56.9	29	215.6	77.1	89	272.1	97.4
50	47.1	16.8	10	103.6	37.1	70	160.1	57.3	30	216.6	77.5	90	273.0	97.7
51	48.0	17.2	111	104.5	37.4	171	161.0	57.6	231	217.5	77.8	291	274.0	98.0
52	49.0	17.5	12	105.5	37.7	72	161.9	57.9	32	218.4	78.2	92	274.9	98.4
53	49.9	17.9	13	106.4	38.1	73	162.9	58.3	33	219.4	78.5	93	275.9	98.7
54	50.8	18.2	14	107.3	38.4	74	163.8	58.6	34	220.3	78.8	94	276.8	99.0
55	51.8	18.5	15	108.3	38.7	75	164.8	59.0	35	221.3	79.2	95	277.8	99.4
56	52.7	18.9	16	109.2	39.1	76	165.7	59.3	36	222.2	79.5	96	278.7	99.7
57	53.7	19.2	17	110.2	39.4	77	166.7	59.6	37	223.1	79.8	97	279.6	100.1
58	54.6	19.5	18	111.1	39.8	78	167.6	60.0	38	224.1	80.2	98	280.6	100.4
59	55.6	19.9	19	112.0	40.1	79	168.5	60.3	39	225.0	80.5	99	281.5	100.7
60	56.5	20.2	20	113.0	40.4	80	169.5	60.6	40	226.0	80.9	300	282.5	101.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.N.E.¼E.			E.S.E.¼E.			W.N.W.¼W.			W.S.W.¼W.			[For 6¼ Points.		

TABLE I.

Difference of Latitude and Departure for 2 Points.

N.N.E.			N.N.W.			S.S.E.			S.S.W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.4	23.3	121	111.8	46.3	181	167.2	69.3	241	222.7	92.2
2	01.8	00.8	62	57.3	23.7	22	112.7	46.7	82	168.1	69.6	42	223.6	92.6
3	02.8	01.1	63	58.2	24.1	23	113.6	47.1	83	169.1	70.0	43	224.5	93.0
4	03.7	01.5	64	59.1	24.5	24	114.6	47.5	84	170.0	70.4	44	225.4	93.4
5	04.6	01.9	65	60.1	24.9	25	115.5	47.8	85	170.9	70.8	45	226.4	93.8
6	05.5	02.3	66	61.0	25.3	26	116.4	48.2	86	171.8	71.2	46	227.3	94.1
7	06.5	02.7	67	61.9	25.6	27	117.3	48.6	87	172.8	71.6	47	228.2	94.5
8	07.4	03.1	68	62.8	26.0	28	118.3	49.0	88	173.7	71.9	48	229.1	94.9
9	08.3	03.4	69	63.7	26.4	29	119.2	49.4	89	174.6	72.3	49	230.0	95.3
10	09.2	03.8	70	64.7	26.8	30	120.1	49.7	90	175.5	72.7	50	231.0	95.7
11	10.2	04.2	71	65.6	27.2	131	121.0	50.1	191	176.5	73.1	251	231.9	96.1
12	11.1	04.6	72	66.5	27.6	32	122.0	50.5	92	177.4	73.5	52	232.8	96.4
13	12.0	05.0	73	67.4	27.9	33	122.9	50.9	93	178.3	73.9	53	233.7	96.8
14	12.9	05.4	74	68.4	28.3	34	123.8	51.3	94	179.2	74.2	54	234.7	97.2
15	13.9	05.7	75	69.3	28.7	35	124.7	51.7	95	180.2	74.6	55	235.6	97.6
16	14.8	06.1	76	70.2	29.1	36	125.6	52.0	96	181.1	75.0	56	236.5	98.0
17	15.7	06.5	77	71.1	29.5	37	126.6	52.4	97	182.0	75.4	57	237.4	98.3
18	16.6	06.9	78	72.1	29.8	38	127.5	52.8	98	182.9	75.8	58	238.4	98.7
19	17.6	07.3	79	73.0	30.2	39	128.4	53.2	99	183.9	76.2	59	239.3	99.1
20	18.5	07.7	80	73.9	30.6	40	129.3	53.6	200	184.8	76.5	60	240.2	99.5
21	19.4	08.0	81	74.8	31.0	141	130.3	54.0	201	185.7	76.9	261	241.1	99.9
22	20.3	08.4	82	75.8	31.4	42	131.2	54.3	02	186.6	77.3	62	242.1	100.3
23	21.2	08.8	83	76.7	31.8	43	132.1	54.7	03	187.5	77.7	63	243.0	100.6
24	22.2	09.2	84	77.6	32.1	44	133.0	55.1	04	188.5	78.1	64	243.9	101.0
25	23.1	09.6	85	78.5	32.5	45	134.0	55.5	05	189.4	78.5	65	244.8	101.4
26	24.0	09.9	86	79.5	32.9	46	134.9	55.9	06	190.3	78.8	66	245.8	101.8
27	24.9	10.3	87	80.4	33.3	47	135.8	56.3	07	191.2	79.2	67	246.7	102.2
28	25.9	10.7	88	81.3	33.7	48	136.7	56.6	08	192.2	79.6	68	247.6	102.6
29	26.8	11.1	89	82.2	34.1	49	137.7	57.0	09	193.1	80.0	69	248.5	102.9
30	27.7	11.5	90	83.1	34.4	50	138.6	57.4	10	194.0	80.4	70	249.4	103.3
31	28.6	11.9	91	84.1	34.8	151	139.5	57.8	211	194.9	80.7	271	250.4	103.7
32	29.6	12.2	92	85.0	35.2	52	140.4	58.2	12	195.9	81.1	72	251.3	104.1
33	30.5	12.6	93	85.9	35.6	53	141.4	58.6	13	196.8	81.5	73	252.2	104.5
34	31.4	13.0	94	86.8	36.0	54	142.3	58.9	14	197.7	81.9	74	253.1	104.9
35	32.3	13.4	95	87.8	36.4	55	143.2	59.3	15	198.6	82.3	75	254.1	105.2
36	33.3	13.8	96	88.7	36.7	56	144.1	59.7	16	199.6	82.7	76	255.0	105.6
37	34.2	14.2	97	89.6	37.1	57	145.0	60.1	17	200.5	83.0	77	255.9	106.0
38	35.1	14.5	98	90.5	37.5	58	146.0	60.5	18	201.4	83.4	78	256.8	106.4
39	36.0	14.9	99	91.5	37.9	59	146.9	60.8	19	202.3	83.8	79	257.8	106.8
40	37.0	15.3	100	92.4	38.3	60	147.8	61.2	20	203.3	84.2	80	258.7	107.2
41	37.9	15.7	101	93.3	38.7	161	148.7	61.6	221	204.2	84.6	281	259.6	107.5
42	38.8	16.1	02	94.2	39.0	62	149.7	62.0	22	205.1	85.0	82	260.5	107.9
43	39.7	16.5	03	95.2	39.4	63	150.6	62.4	23	206.0	85.3	83	261.5	108.3
44	40.7	16.8	04	96.1	39.8	64	151.5	62.8	24	206.9	85.7	84	262.4	108.7
45	41.6	17.2	05	97.0	40.2	65	152.4	63.1	25	207.9	86.1	85	263.3	109.1
46	42.5	17.6	06	97.9	40.6	66	153.4	63.5	26	208.8	86.5	86	264.2	109.4
47	43.4	18.0	07	98.9	40.9	67	154.3	63.9	27	209.7	86.9	87	265.2	109.8
48	44.3	18.4	08	99.8	41.3	68	155.2	64.3	28	210.6	87.3	88	266.1	110.2
49	45.3	18.8	09	100.7	41.7	69	156.1	64.7	29	211.6	87.6	89	267.0	110.6
50	46.2	19.1	10	101.6	42.1	70	157.1	65.1	30	212.5	88.0	90	267.9	111.0
51	47.1	19.5	111	102.6	42.5	171	158.0	65.4	231	213.4	88.4	291	268.8	111.4
52	48.0	19.9	12	103.5	42.9	72	158.9	65.8	32	214.3	88.8	92	269.8	111.7
53	49.0	20.3	13	104.4	43.2	73	159.8	66.2	33	215.3	89.2	93	270.7	112.1
54	49.9	20.7	14	105.3	43.6	74	160.8	66.6	34	216.2	89.5	94	271.6	112.5
55	50.8	21.0	15	106.2	44.0	75	161.7	67.0	35	217.1	89.9	95	272.5	112.9
56	51.7	21.4	16	107.2	44.4	76	162.6	67.4	36	218.0	90.3	96	273.5	113.3
57	52.7	21.8	17	108.1	44.8	77	163.5	67.7	37	219.0	90.7	97	274.4	113.7
58	53.6	22.2	18	109.0	45.2	78	164.5	68.1	38	219.9	91.1	98	275.3	114.0
59	54.5	22.6	19	109.9	45.5	79	165.4	68.5	39	220.8	91.5	99	276.2	114.4
60	55.4	23.0	20	110.9	45.9	80	166.3	68.9	40	221.7	91.8	300	277.2	114.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
E.N.E.			E.S.E.			W.N.W.			W.S.W.			[For 6 Points.		

TABLE I.

Difference of Latitude and Departure for 2¼ Points.

N.N.E.¼E.			N.N.W.¼W.			S.S.E.¼E.			S.S.W.¼W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.1	26.1	121	109.4	51.7	181	163.6	77.4	241	217.9	103.0
2	01.8	00.9	62	56.0	26.5	22	110.3	52.2	82	164.5	77.8	42	218.8	103.5
3	02.7	01.3	63	57.0	26.9	23	111.2	52.6	83	165.4	78.2	43	219.7	103.9
4	03.6	01.7	64	57.9	27.4	24	112.1	53.0	84	166.3	78.7	44	220.6	104.3
5	04.5	02.1	65	58.8	27.8	25	113.0	53.4	85	167.2	79.1	45	221.5	104.8
6	05.4	02.6	66	59.7	28.2	26	113.9	53.9	86	168.1	79.5	46	222.4	105.2
7	06.3	03.0	67	60.6	28.6	27	114.8	54.3	87	169.0	80.0	47	223.3	105.6
8	07.2	03.4	68	61.5	29.1	28	115.7	54.7	88	169.9	80.4	48	224.2	106.0
9	08.1	03.8	69	62.4	29.5	29	116.6	55.2	89	170.9	80.8	49	225.1	106.5
10	09.0	04.3	70	63.3	29.9	30	117.5	55.6	90	171.8	81.2	50	226.0	106.9
11	09.9	04.7	71	64.2	30.4	131	118.4	56.0	191	172.7	81.7	251	226.9	107.3
12	10.8	05.1	72	65.1	30.8	32	119.3	56.4	92	173.6	82.1	52	227.8	107.7
13	11.8	05.6	73	66.0	31.2	33	120.2	56.9	93	174.5	82.5	53	228.7	108.2
14	12.7	06.0	74	66.9	31.6	34	121.1	57.3	94	175.4	82.9	54	229.6	108.6
15	13.6	06.4	75	67.8	32.1	35	122.0	57.7	95	176.3	83.4	55	230.5	109.0
16	14.5	06.8	76	68.7	32.5	36	122.9	58.1	96	177.2	83.8	56	231.4	109.5
17	15.4	07.3	77	69.6	32.9	37	123.8	58.6	97	178.1	84.2	57	232.3	109.9
18	16.3	07.7	78	70.5	33.3	38	124.8	59.0	98	179.0	84.7	58	233.2	110.3
19	17.2	08.1	79	71.4	33.8	39	125.7	59.4	99	179.9	85.1	59	234.1	110.7
20	18.1	08.6	80	72.3	34.2	40	126.6	59.9	200	180.8	85.5	60	235.0	111.2
21	19.0	09.0	81	73.2	34.6	141	127.5	60.3	201	181.7	85.9	261	235.9	111.6
22	19.9	09.4	82	74.1	35.1	42	128.4	60.7	02	182.6	86.4	62	236.8	112.0
23	20.8	09.8	83	75.0	35.5	43	129.3	61.1	03	183.5	86.8	63	237.7	112.4
24	21.7	10.3	84	75.9	35.9	44	130.2	61.6	04	184.4	87.2	64	238.7	112.9
25	22.6	10.7	85	76.8	36.3	45	131.1	62.0	05	185.3	87.6	65	239.6	113.3
26	23.5	11.1	86	77.7	36.8	46	132.0	62.4	06	186.2	88.1	66	240.5	113.7
27	24.4	11.5	87	78.6	37.2	47	132.9	62.9	07	187.1	88.5	67	241.4	114.2
28	25.3	12.0	88	79.6	37.6	48	133.8	63.3	08	188.0	88.9	68	242.3	114.6
29	26.2	12.4	89	80.5	38.1	49	134.7	63.7	09	188.9	89.4	69	243.2	115.0
30	27.1	12.8	90	81.4	38.5	50	135.6	64.1	10	189.8	89.8	70	244.1	115.4
31	28.0	13.3	91	82.3	38.9	151	136.5	64.6	211	190.7	90.2	271	245.0	115.9
32	28.9	13.7	92	83.2	39.3	52	137.4	65.0	12	191.6	90.6	72	245.9	116.3
33	29.8	14.1	93	84.1	39.8	53	138.3	65.4	13	192.5	91.1	73	246.8	116.7
34	30.7	14.5	94	85.0	40.2	54	139.2	65.8	14	193.5	91.5	74	247.7	117.2
35	31.6	15.0	95	85.9	40.6	55	140.1	66.3	15	194.4	91.9	75	248.6	117.6
36	32.5	15.4	96	86.8	41.0	56	141.0	66.7	16	195.3	92.4	76	249.5	118.0
37	33.4	15.8	97	87.7	41.5	57	141.9	67.1	17	196.2	92.8	77	250.4	118.4
38	34.4	16.2	98	88.6	41.9	58	142.8	67.6	18	197.1	93.2	78	251.3	118.9
39	35.3	16.7	99	89.5	42.3	59	143.7	68.0	19	198.0	93.6	79	252.2	119.3
40	36.2	17.1	100	90.4	42.8	60	144.6	68.4	20	198.9	94.1	80	253.1	119.7
41	37.1	17.5	101	91.3	43.2	161	145.5	68.8	221	199.8	94.5	281	254.0	120.1
42	38.0	18.0	02	92.2	43.6	62	146.4	69.3	22	200.7	94.9	82	254.9	120.6
43	38.9	18.4	03	93.1	44.0	63	147.4	69.7	23	201.6	95.3	83	255.8	121.0
44	39.8	18.8	04	94.0	44.5	64	148.3	70.1	24	202.5	95.8	84	256.7	121.4
45	40.7	19.2	05	94.9	44.9	65	149.2	70.5	25	203.4	96.2	85	257.6	121.9
46	41.6	19.7	06	95.8	45.3	66	150.1	71.0	26	204.3	96.6	86	258.5	122.3
47	42.5	20.1	07	96.7	45.7	67	151.0	71.4	27	205.2	97.1	87	259.4	122.7
48	43.4	20.5	08	97.6	46.2	68	151.9	71.8	28	206.1	97.5	88	260.3	123.1
49	44.3	21.0	09	98.5	46.6	69	152.8	72.3	29	207.0	97.9	89	261.3	123.6
50	45.2	21.4	10	99.4	47.0	70	153.7	72.7	30	207.9	98.3	90	262.2	124.0
51	46.1	21.8	111	100.3	47.5	171	154.6	73.1	231	208.8	98.8	291	263.1	124.4
52	47.0	22.2	12	101.2	47.9	72	155.5	73.5	32	209.7	99.2	92	264.0	124.8
53	47.9	22.7	13	102.2	48.3	73	156.4	74.0	33	210.6	99.6	93	264.9	125.3
54	48.8	23.1	14	103.1	48.7	74	157.3	74.4	34	211.5	100.0	94	265.8	125.7
55	49.7	23.5	15	104.0	49.2	75	158.2	74.8	35	212.4	100.5	95	266.7	126.1
56	50.6	23.9	16	104.9	49.6	76	159.1	75.2	36	213.3	100.9	96	267.6	126.6
57	51.5	24.4	17	105.8	50.0	77	160.0	75.7	37	214.2	101.3	97	268.5	127.0
58	52.4	24.8	18	106.7	50.5	78	160.9	76.1	38	215.1	101.8	98	269.4	127.4
59	53.3	25.2	19	107.6	50.9	79	161.8	76.5	39	216.1	102.2	99	270.3	127.8
60	54.2	25.7	20	108.5	51.3	80	162.7	77.0	40	217.0	102.6	300	271.2	128.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.b.E.¾E.			S.E.b.E.¾E.			N.W.b.W.¾W.			S.W.b.W.¾W.			[For 5¾ Points.		

TABLE I.

Difference of Latitude and Departure for 2½ Points.

N.N.E.½E.			N.N.W.½W.			S.S.E.½E.			S.S.W.½W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.8	28.8	121	106.7	57.0	181	159.6	85.3	241	212.5	113.6
2	01.8	00.9	62	54.7	29.2	22	107.6	57.5	82	160.5	85.8	42	213.4	114.1
3	02.6	01.4	63	55.6	29.7	23	108.5	58.0	83	161.4	86.3	43	214.3	114.5
4	03.5	01.9	64	56.4	30.2	24	109.4	58.5	84	162.3	86.7	44	215.2	115.0
5	04.4	02.4	65	57.3	30.6	25	110.2	58.9	85	163.2	87.2	45	216.1	115.5
6	05.3	02.8	66	58.2	31.1	26	111.1	59.4	86	164.0	87.7	46	217.0	116.0
7	06.2	03.3	67	59.1	31.6	27	112.0	59.9	87	164.9	88.2	47	217.8	116.4
8	07.1	03.8	68	60.0	32.1	28	112.9	60.3	88	165.8	88.6	48	218.7	116.9
9	07.9	04.2	69	60.9	32.5	29	113.8	60.8	89	166.7	89.1	49	219.6	117.4
10	08.8	04.7	70	61.7	33.0	30	114.6	61.3	90	167.6	89.6	50	220.5	117.8
11	09.7	05.2	71	62.6	33.5	131	115.5	61.8	191	168.4	90.0	251	221.4	118.3
12	10.6	05.7	72	63.5	33.9	32	116.4	62.2	92	169.3	90.5	52	222.2	118.8
13	11.5	06.1	73	64.4	34.4	33	117.3	62.7	93	170.2	91.0	53	223.1	119.3
14	12.3	06.6	74	65.3	34.9	34	118.2	63.2	94	171.1	91.5	54	224.0	119.7
15	13.2	07.1	75	66.1	35.4	35	119.1	63.6	95	172.0	91.9	55	224.9	120.2
16	14.1	07.5	76	67.0	35.8	36	119.9	64.1	96	172.9	92.4	56	225.8	120.7
17	15.0	08.0	77	67.9	36.3	37	120.8	64.6	97	173.7	92.9	57	226.7	121.1
18	15.9	08.5	78	68.8	36.8	38	121.7	65.1	98	174.6	93.3	58	227.5	121.6
19	16.8	09.0	79	69.7	37.2	39	122.6	65.5	99	175.5	93.8	59	228.4	122.1
20	17.6	09.4	80	70.6	37.7	40	123.5	66.0	200	176.4	94.3	60	229.3	122.6
21	18.5	09.9	81	71.4	38.2	141	124.4	66.5	201	177.3	94.8	261	230.2	123.0
22	19.4	10.4	82	72.3	38.7	42	125.2	66.9	02	178.1	95.2	62	231.1	123.5
23	20.3	10.8	83	73.2	39.1	43	126.1	67.4	03	179.0	95.7	63	231.9	124.0
24	21.2	11.3	84	74.1	39.6	44	127.0	67.9	04	179.9	96.2	64	232.8	124.4
25	22.0	11.8	85	75.0	40.1	45	127.9	68.4	05	180.8	96.6	65	233.7	124.9
26	22.9	12.3	86	75.8	40.5	46	128.8	68.8	06	181.7	97.1	66	234.6	125.4
27	23.8	12.7	87	76.7	41.0	47	129.6	69.3	07	182.6	97.6	67	235.5	125.9
28	24.7	13.2	88	77.6	41.5	48	130.5	69.8	08	183.4	98.1	68	236.4	126.3
29	25.6	13.7	89	78.5	42.0	49	131.4	70.2	09	184.3	98.5	69	237.2	126.8
30	26.5	14.1	90	79.4	42.4	50	132.3	70.7	10	185.2	99.0	70	238.1	127.3
31	27.3	14.6	91	80.3	42.9	151	133.2	71.2	211	186.1	99.5	271	239.0	127.7
32	28.2	15.1	92	81.1	43.4	52	134.1	71.7	12	187.0	99.9	72	239.9	128.2
33	29.1	15.6	93	82.0	43.8	53	134.9	72.1	13	187.8	100.4	73	240.8	128.7
34	30.0	16.0	94	82.9	44.3	54	135.8	72.6	14	188.7	100.9	74	241.6	129.2
35	30.9	16.5	95	83.8	44.8	55	136.7	73.1	15	189.6	101.4	75	242.5	129.6
36	31.7	17.0	96	84.7	45.3	56	137.6	73.5	16	190.5	101.8	76	243.4	130.1
37	32.6	17.4	97	85.5	45.7	57	138.5	74.0	17	191.4	102.3	77	244.3	130.6
38	33.5	17.9	98	86.4	46.2	58	139.3	74.5	18	192.3	102.8	78	245.2	131.0
39	34.4	18.4	99	87.3	46.7	59	140.2	75.0	19	193.1	103.2	79	246.1	131.5
40	35.3	18.9	100	88.2	47.1	60	141.1	75.4	20	194.0	103.7	80	246.9	132.0
41	36.2	19.3	101	89.1	47.6	161	142.0	75.9	221	194.9	104.2	281	247.8	132.5
42	37.0	19.8	02	90.0	48.1	62	142.9	76.4	22	195.8	104.7	82	248.7	132.9
43	37.9	20.3	03	90.8	48.6	63	143.8	76.8	23	196.7	105.1	83	249.6	133.4
44	38.8	20.7	04	91.7	49.0	64	144.6	77.3	24	197.6	105.6	84	250.5	133.9
45	39.7	21.2	05	92.6	49.5	65	145.5	77.8	25	198.4	106.1	85	251.3	134.3
46	40.6	21.7	06	93.5	50.0	66	146.4	78.3	26	199.3	106.5	86	252.2	134.8
47	41.5	22.2	07	94.4	50.4	67	147.3	78.7	27	200.2	107.0	87	253.1	135.3
48	42.3	22.6	08	95.2	50.9	68	148.2	79.2	28	201.1	107.5	88	254.0	135.8
49	43.2	23.1	09	96.1	51.4	69	149.0	79.7	29	202.0	107.9	89	254.9	136.2
50	44.1	23.6	10	97.0	51.9	70	149.9	80.1	30	202.8	108.4	90	255.8	136.7
51	45.0	24.0	111	97.9	52.3	171	150.8	80.6	231	203.7	108.9	291	256.6	137.2
52	45.9	24.5	12	98.8	52.8	72	151.7	81.1	32	204.6	109.4	92	257.5	137.6
53	46.7	25.0	13	99.7	53.3	73	152.6	81.6	33	205.5	109.8	93	258.4	138.1
54	47.6	25.5	14	100.5	53.7	74	153.5	82.0	34	206.4	110.3	94	259.3	138.6
55	48.5	25.9	15	101.4	54.2	75	154.3	82.5	35	207.3	110.8	95	260.2	139.1
56	49.4	26.4	16	102.3	54.7	76	155.2	83.0	36	208.1	111.2	96	261.0	139.5
57	50.3	26.9	17	103.2	55.2	77	156.1	83.4	37	209.0	111.7	97	261.9	140.0
58	51.2	27.3	18	104.1	55.6	78	157.0	83.9	38	209.9	112.2	98	262.8	140.5
59	52.0	27.8	19	104.9	56.1	79	157.9	84.4	39	210.8	112.7	99	263.7	140.9
60	52.9	28.3	20	105.8	56.6	80	158.7	84.9	40	211.7	113.1	300	264.6	141.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.b.E.½E.			S.E.b.E.½E.			N.W.b.W.½W.			S.W.b.W.½W.			[For 5½ Points.		

Difference of Latitude and Departure for 2¾ Points.

N.N.E.¾E.			N.N.W.¾W.			S.S.E.¾E.			S.S.W.¾W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.8	62.2	181	155.2	93.1	241	206.7	123.9
2	01.7	01.0	62	53.2	31.9	22	104.6	62.7	82	156.1	93.6	42	207.6	124.4
3	02.6	01.5	63	54.0	32.4	23	105.5	63.2	83	157.0	94.1	43	208.4	124.9
4	03.4	02.1	64	54.9	32.9	24	106.4	63.7	84	157.8	94.6	44	209.3	125.4
5	04.3	02.6	65	55.8	33.4	25	107.2	64.3	85	158.7	95.1	45	210.1	126.0
6	05.1	03.1	66	56.6	33.9	26	108.1	64.8	86	159.5	95.6	46	211.0	126.5
7	06.0	03.6	67	57.5	34.4	27	108.9	65.3	87	160.4	96.1	47	211.9	127.0
8	06.9	04.1	68	58.3	35.0	28	109.8	65.8	88	161.3	96.7	48	212.7	127.5
9	07.7	04.6	69	59.2	35.5	29	110.6	66.3	89	162.1	97.2	49	213.6	128.0
10	08.6	05.1	70	60.0	36.0	30	111.5	66.8	90	163.0	97.7	50	214.4	128.5
11	09.4	05.7	71	60.9	36.5	131	112.4	67.3	191	163.8	98.2	251	215.3	129.0
12	10.3	06.2	72	61.8	37.0	32	113.2	67.9	92	164.7	98.7	52	216.1	129.6
13	11.2	06.7	73	62.6	37.5	33	114.1	68.4	93	165.5	99.2	53	217.0	130.1
14	12.0	07.2	74	63.5	38.0	34	114.9	68.9	94	166.4	99.7	54	217.9	130.6
15	12.9	07.7	75	64.3	38.6	35	115.8	69.4	95	167.3	100.3	55	218.7	131.1
16	13.7	08.2	76	65.2	39.1	36	116.7	69.9	96	168.1	100.8	56	219.6	131.6
17	14.6	08.7	77	66.0	39.6	37	117.5	70.4	97	169.0	101.3	57	220.4	132.1
18	15.4	09.3	78	66.9	40.1	38	118.4	70.9	98	169.8	101.8	58	221.3	132.6
19	16.3	09.8	79	67.8	40.6	39	119.2	71.5	99	170.7	102.3	59	222.2	133.2
20	17.2	10.3	80	68.6	41.1	40	120.1	72.0	200	171.5	102.8	60	223.0	133.7
21	18.0	10.8	81	69.5	41.6	141	120.9	72.5	201	172.4	103.3	261	223.9	134.2
22	18.9	11.3	82	70.3	42.2	42	121.8	73.0	02	173.3	103.8	62	224.7	134.7
23	19.7	11.8	83	71.2	42.7	43	122.7	73.5	03	174.1	104.4	63	225.6	135.2
24	20.6	12.3	84	72.0	43.2	44	123.5	74.0	04	175.0	104.9	64	226.4	135.7
25	21.4	12.9	85	72.9	43.7	45	124.4	74.5	05	175.8	105.4	65	227.3	136.2
26	22.3	13.4	86	73.8	44.2	46	125.2	75.1	06	176.7	105.9	66	228.2	136.8
27	23.2	13.9	87	74.6	44.7	47	126.1	75.6	07	177.5	106.4	67	229.0	137.3
28	24.0	14.4	88	75.5	45.2	48	126.9	76.1	08	178.4	106.9	68	229.9	137.8
29	24.9	14.9	89	76.3	45.8	49	127.8	76.6	09	179.3	107.4	69	230.7	138.3
30	25.7	15.4	90	77.2	46.3	50	128.7	77.1	10	180.1	108.0	70	231.6	138.8
31	26.6	15.9	91	78.1	46.8	151	129.5	77.6	211	181.0	108.5	271	232.4	139.3
32	27.4	16.5	92	78.9	47.3	52	130.4	78.1	12	181.8	109.0	72	233.3	139.8
33	28.3	17.0	93	79.8	47.8	53	131.2	78.7	13	182.7	109.5	73	234.2	140.4
34	29.2	17.5	94	80.6	48.3	54	132.1	79.2	14	183.6	110.0	74	235.0	140.9
35	30.0	18.0	95	81.5	48.8	55	132.9	79.7	15	184.4	110.5	75	235.9	141.4
36	30.9	18.5	96	82.3	49.4	56	133.8	80.2	16	185.3	111.0	76	236.7	141.9
37	31.7	19.0	97	83.2	49.9	57	134.7	80.7	17	186.1	111.6	77	237.6	142.4
38	32.6	19.5	98	84.1	50.4	58	135.5	81.2	18	187.0	112.1	78	238.4	142.9
39	33.5	20.1	99	84.9	50.9	59	136.4	81.7	19	187.8	112.6	79	239.3	143.4
40	34.3	20.6	100	85.8	51.4	60	137.2	82.3	20	188.7	113.1	80	240.2	143.9
41	35.2	21.1	101	86.6	51.9	161	138.1	82.8	221	189.6	113.6	281	241.0	144.5
42	36.0	21.6	02	87.5	52.4	62	139.0	83.3	22	190.4	114.1	82	241.9	145.0
43	36.9	22.1	03	88.3	53.0	63	139.8	83.8	23	191.3	114.6	83	242.7	145.5
44	37.7	22.6	04	89.2	53.5	64	140.7	84.3	24	192.1	115.2	84	243.6	146.0
45	38.6	23.1	05	90.1	54.0	65	141.5	84.8	25	193.0	115.7	85	244.5	146.5
46	39.5	23.6	06	90.9	54.5	66	142.4	85.3	26	193.8	116.2	86	245.3	147.0
47	40.3	24.2	07	91.8	55.0	67	143.2	85.9	27	194.7	116.7	87	246.2	147.5
48	41.2	24.7	08	92.6	55.5	68	144.1	86.4	28	195.6	117.2	88	247.0	148.1
49	42.0	25.2	09	93.5	56.0	69	145.0	86.9	29	196.4	117.7	89	247.9	148.6
50	42.9	25.7	10	94.4	56.6	70	145.8	87.4	30	197.3	118.2	90	248.7	149.1
51	43.7	26.2	111	95.2	57.1	171	146.7	87.9	231	198.1	118.8	291	249.6	149.6
52	44.6	26.7	12	96.1	57.6	72	147.5	88.4	32	199.0	119.3	92	250.5	150.1
53	45.5	27.2	13	96.9	58.1	73	148.4	88.9	33	199.9	119.8	93	251.3	150.6
54	46.3	27.8	14	97.8	58.6	74	149.2	89.5	34	200.7	120.3	94	252.2	151.1
55	47.2	28.3	15	98.6	59.1	75	150.1	90.0	35	201.6	120.8	95	253.0	151.7
56	48.0	28.8	16	99.5	59.6	76	151.0	90.5	36	202.4	121.3	96	253.9	152.2
57	48.9	29.3	17	100.4	60.2	77	151.8	91.0	37	203.3	121.8	97	254.7	152.7
58	49.7	29.8	18	101.2	60.7	78	152.7	91.5	38	204.1	122.4	98	255.6	153.2
59	50.6	30.3	19	102.1	61.2	79	153.5	92.0	39	205.0	122.9	99	256.5	153.7
60	51.5	30.8	20	102.9	61.7	80	154.4	92.5	40	205.9	123.4	300	257.3	154.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.b.E.¼E.			S.E.b.E.¼E.			N.W.b.W.¼W.			S.W.b.W.¼W.			[For 5¼ Points.		

TABLE I.

Difference of Latitude and Departure for 3 Points.

N.E.b.N.			N.W.b.N.			S.E.b.S.			S.W.b.S.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.7	33.9	121	100.6	67.2	181	150.5	100.5	241	200.4	133.9
2	01.7	01.1	62	51.6	34.4	22	101.4	67.8	82	151.3	101.1	42	201.2	134.4
3	02.5	01.7	63	52.4	35.0	23	102.3	68.3	83	152.2	101.7	43	202.0	135.0
4	03.3	02.2	64	53.2	35.6	24	103.1	68.9	84	153.0	102.2	44	202.9	135.5
5	04.2	02.8	65	54.0	36.1	25	103.9	69.4	85	153.8	102.8	45	203.7	136.1
6	05.0	03.3	66	54.9	36.7	26	104.8	70.0	86	154.7	103.3	46	204.5	136.7
7	05.8	03.9	67	55.7	37.2	27	105.6	70.5	87	155.5	103.9	47	205.4	137.2
8	06.7	04.4	68	56.5	37.8	28	106.4	71.1	88	156.3	104.4	48	206.2	137.8
9	07.5	05.0	69	57.4	38.3	29	107.3	71.7	89	157.1	105.0	49	207.0	138.3
10	08.3	05.6	70	58.2	38.9	30	108.1	72.2	90	158.0	105.5	50	207.9	138.9
11	09.1	06.1	71	59.0	39.4	131	108.9	72.8	191	158.8	106.1	251	208.7	139.4
12	10.0	06.7	72	59.9	40.0	32	109.8	73.3	92	159.6	106.7	52	209.5	140.0
13	10.8	07.2	73	60.7	40.6	33	110.6	73.9	93	160.5	107.2	53	210.4	140.5
14	11.6	07.8	74	61.5	41.1	34	111.4	74.4	94	161.3	107.8	54	211.2	141.1
15	12.5	08.3	75	62.4	41.7	35	112.2	75.0	95	162.1	108.3	55	212.0	141.7
16	13.3	08.9	76	63.2	42.2	36	113.1	75.5	96	163.0	108.9	56	212.9	142.2
17	14.1	09.4	77	64.0	42.8	37	113.9	76.1	97	163.8	109.4	57	213.7	142.8
18	15.0	10.0	78	64.9	43.3	38	114.7	76.7	98	164.6	110.0	58	214.5	143.3
19	15.8	10.6	79	65.7	43.9	39	115.6	77.2	99	165.5	110.5	59	215.4	143.9
20	16.6	11.1	80	66.5	44.4	40	116.4	77.8	200	166.3	111.1	60	216.2	144.4
21	17.5	11.7	81	67.3	45.0	141	117.2	78.3	201	167.1	111.7	261	217.0	145.0
22	18.3	12.2	82	68.2	45.6	42	118.1	78.9	02	168.0	112.2	62	217.8	145.5
23	19.1	12.8	83	69.0	46.1	43	118.9	79.4	03	168.8	112.8	63	218.7	146.1
24	20.0	13.3	84	69.8	46.7	44	119.7	80.0	04	169.6	113.3	64	219.5	146.7
25	20.8	13.9	85	70.7	47.2	45	120.6	80.5	05	170.5	113.9	65	220.3	147.2
26	21.6	14.4	86	71.5	47.8	46	121.4	81.1	06	171.3	114.4	66	221.2	147.8
27	22.4	15.0	87	72.3	48.3	47	122.2	81.7	07	172.1	115.0	67	222.0	148.3
28	23.3	15.6	88	73.2	48.9	48	123.1	82.2	08	172.9	115.5	68	222.8	148.9
29	24.1	16.1	89	74.0	49.4	49	123.9	82.8	09	173.8	116.1	69	223.7	149.4
30	24.9	16.7	90	74.8	50.0	50	124.7	83.3	10	174.6	116.7	70	224.5	150.0
31	25.8	17.2	91	75.7	50.6	151	125.6	83.9	211	175.4	117.2	271	225.3	150.5
32	26.6	17.8	92	76.5	51.1	52	126.4	84.4	12	176.3	117.8	72	226.2	151.1
33	27.4	18.3	93	77.3	51.7	53	127.2	85.0	13	177.1	118.3	73	227.0	151.7
34	28.3	18.9	94	78.2	52.2	54	128.0	85.5	14	177.9	118.9	74	227.8	152.2
35	29.1	19.4	95	79.0	52.8	55	128.9	86.1	15	178.8	119.4	75	228.7	152.8
36	29.9	20.0	96	79.8	53.3	56	129.7	86.7	16	179.6	120.0	76	229.5	153.3
37	30.8	20.6	97	80.7	53.9	57	130.5	87.2	17	180.4	120.5	77	230.3	153.9
38	31.6	21.1	98	81.5	54.4	58	131.4	87.8	18	181.3	121.1	78	231.1	154.4
39	32.4	21.7	99	82.3	55.0	59	132.2	88.3	19	182.1	121.7	79	232.0	155.0
40	33.3	22.2	100	83.1	55.6	60	133.0	88.9	20	182.9	122.2	80	232.8	155.5
41	34.1	22.8	101	84.0	56.1	161	133.9	89.4	221	183.8	122.8	281	233.6	156.1
42	34.9	23.3	02	84.8	56.7	62	134.7	90.0	22	184.6	123.3	82	234.5	156.7
43	35.8	23.9	03	85.6	57.2	63	135.5	90.5	23	185.4	123.9	83	235.3	157.2
44	36.6	24.4	04	86.5	57.8	64	136.4	91.1	24	186.2	124.4	84	236.1	157.8
45	37.4	25.0	05	87.3	58.3	65	137.2	91.7	25	187.1	125.0	85	237.0	158.3
46	38.2	25.6	06	88.1	58.9	66	138.0	92.2	26	187.9	125.5	86	237.8	158.9
47	39.1	26.1	07	89.0	59.4	67	138.9	92.8	27	188.7	126.1	87	238.6	159.4
48	39.9	26.7	08	89.8	60.0	68	139.7	93.3	28	189.6	126.7	88	239.5	160.0
49	40.7	27.2	09	90.6	60.6	69	140.5	93.9	29	190.4	127.2	89	240.3	160.5
50	41.6	27.8	10	91.5	61.1	70	141.3	94.4	30	191.2	127.8	90	241.1	161.1
51	42.4	28.3	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3	291	242.0	161.7
52	43.2	28.9	12	93.1	62.2	72	143.0	95.5	32	192.9	128.9	92	242.8	162.2
53	44.1	29.4	13	94.0	62.8	73	143.8	96.1	33	193.7	129.4	93	243.6	162.8
54	44.9	30.0	14	94.8	63.3	74	144.7	96.7	34	194.6	130.0	94	244.5	163.3
55	45.7	30.6	15	95.6	63.9	75	145.5	97.2	35	195.4	130.5	95	245.3	163.9
56	46.6	31.1	16	96.5	64.4	76	146.3	97.8	36	196.2	131.1	96	246.1	164.4
57	47.4	31.7	17	97.3	65.0	77	147.2	98.3	37	197.1	131.7	97	246.9	165.0
58	48.2	32.2	18	98.1	65.5	78	148.0	98.9	38	197.9	132.2	98	247.8	165.5
59	49.1	32.8	19	98.9	66.1	79	148.8	99.4	39	198.7	132.8	99	248.6	166.1
60	49.9	33.3	20	99.8	66.7	80	149.7	100.0	40	199.6	133.3	300	249.4	166.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.b.E.			S.E.b.E.			N.W.b.W.			S.W.b.W.			[For 5 Points.		

Difference of Latitude and Departure for 3¾ Points.

N.E.¾N.			N.W.¾N.			S.E.¾S.			S.W.¾S.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	49.0	36.3	121	97.2	72.1	181	145.4	107.8	241	193.6	143.6
2	01.6	01.2	62	49.8	36.9	22	98.0	72.7	82	146.2	108.4	42	194.4	144.2
3	02.4	01.8	63	50.6	37.5	23	98.8	73.3	83	147.0	109.0	43	195.2	144.8
4	03.2	02.4	64	51.4	38.1	24	99.6	73.9	84	147.8	109.6	44	196.0	145.4
5	04.0	03.0	65	52.2	38.7	25	100.4	74.5	85	148.6	110.2	45	196.8	145.9
6	04.8	03.6	66	53.0	39.3	26	101.2	75.1	86	149.4	110.8	46	197.6	146.5
7	05.6	04.2	67	53.8	39.9	27	102.0	75.7	87	150.2	111.4	47	198.4	147.1
8	06.4	04.8	68	54.6	40.5	28	102.8	76.2	88	151.0	112.0	48	199.2	147.7
9	07.2	05.4	69	55.4	41.1	29	103.6	76.8	89	151.8	112.6	49	200.0	148.3
10	08.0	06.0	70	56.2	41.7	30	104.4	77.4	90	152.6	113.2	50	200.8	148.9
11	08.8	06.6	71	57.0	42.3	131	105.2	78.0	191	153.4	113.8	251	201.6	149.5
12	09.6	07.1	72	57.8	42.9	32	106.0	78.6	92	154.2	114.4	52	202.4	150.1
13	10.4	07.7	73	58.6	43.5	33	106.8	79.2	93	155.0	115.0	53	203.2	150.7
14	11.2	08.3	74	59.4	44.1	34	107.6	79.8	94	155.8	115.6	54	204.0	151.3
15	12.0	08.9	75	60.2	44.7	35	108.4	80.4	95	156.6	116.2	55	204.8	151.9
16	12.9	09.5	76	61.0	45.3	36	109.2	81.0	96	157.4	116.8	56	205.6	152.5
17	13.7	10.1	77	61.8	45.9	37	110.0	81.6	97	158.2	117.4	57	206.4	153.1
18	14.5	10.7	78	62.7	46.5	38	110.8	82.2	98	159.0	117.9	58	207.2	153.7
19	15.3	11.3	79	63.5	47.1	39	111.6	82.8	99	159.8	118.5	59	208.0	154.3
20	16.1	11.9	80	64.3	47.7	40	112.4	83.4	200	160.6	119.1	60	208.8	154.9
21	16.9	12.5	81	65.1	48.3	141	113.3	84.0	201	161.4	119.7	261	209.6	155.5
22	17.7	13.1	82	65.9	48.8	42	114.1	84.6	02	162.2	120.3	62	210.4	156.1
23	18.5	13.7	83	66.7	49.4	43	114.9	85.2	03	163.1	120.9	63	211.2	156.7
24	19.3	14.3	84	67.5	50.0	44	115.7	85.8	04	163.9	121.5	64	212.0	157.3
25	20.1	14.9	85	68.3	50.6	45	116.5	86.4	05	164.7	122.1	65	212.8	157.9
26	20.9	15.5	86	69.1	51.2	46	117.3	87.0	06	165.5	122.7	66	213.7	158.5
27	21.7	16.1	87	69.9	51.8	47	118.1	87.6	07	166.3	123.3	67	214.5	159.1
28	22.5	16.7	88	70.7	52.4	48	118.9	88.2	08	167.1	123.9	68	215.3	159.6
29	23.3	17.3	89	71.5	53.0	49	119.7	88.8	09	167.9	124.5	69	216.1	160.2
30	24.1	17.9	90	72.3	53.6	50	120.5	89.4	10	168.7	125.1	70	216.9	160.8
31	24.9	18.5	91	73.1	54.2	151	121.3	90.0	211	169.5	125.7	271	217.7	161.4
32	25.7	19.1	92	73.9	54.8	52	122.1	90.5	12	170.3	126.3	72	218.5	162.0
33	26.5	19.7	93	74.7	55.4	53	122.9	91.1	13	171.1	126.9	73	219.3	162.6
34	27.3	20.3	94	75.5	56.0	54	123.7	91.7	14	171.9	127.5	74	220.1	163.2
35	28.1	20.8	95	76.3	56.6	55	124.5	92.3	15	172.7	128.1	75	220.9	163.8
36	28.9	21.4	96	77.1	57.2	56	125.3	92.9	16	173.5	128.7	76	221.7	164.4
37	29.7	22.0	97	77.9	57.8	57	126.1	93.5	17	174.3	129.3	77	222.5	165.0
38	30.5	22.6	98	78.7	58.4	58	126.9	94.1	18	175.1	129.9	78	223.3	165.6
39	31.3	23.2	99	79.5	59.0	59	127.7	94.7	19	175.9	130.5	79	224.1	166.2
40	32.1	23.8	100	80.3	59.6	60	128.5	95.3	20	176.7	131.1	80	224.9	166.8
41	32.9	24.4	101	81.1	60.2	161	129.3	95.9	221	177.5	131.6	281	225.7	167.4
42	33.7	25.0	02	81.9	60.8	62	130.1	96.5	22	178.3	132.2	82	226.5	168.0
43	34.5	25.6	03	82.7	61.4	63	130.9	97.1	23	179.1	132.8	83	227.3	168.6
44	35.3	26.2	04	83.5	62.0	64	131.7	97.7	24	179.9	133.4	84	228.1	169.2
45	36.1	26.8	05	84.3	62.5	65	132.5	98.3	25	180.7	134.0	85	228.9	169.8
46	36.9	27.4	06	85.1	63.1	66	133.3	98.9	26	181.5	134.6	86	229.7	170.4
47	37.8	28.0	07	85.9	63.7	67	134.1	99.5	27	182.3	135.2	87	230.5	171.0
48	38.6	28.6	08	86.7	64.3	68	134.9	100.1	28	183.1	135.8	88	231.3	171.6
49	39.4	29.2	09	87.5	64.9	69	135.7	100.7	29	183.9	136.4	89	232.1	172.2
50	40.2	29.8	110	88.4	65.5	70	136.5	101.3	30	184.7	137.0	90	232.9	172.8
51	41.0	30.4	111	89.2	66.1	171	137.3	101.9	231	185.5	137.6	291	233.7	173.3
52	41.8	31.0	12	90.0	66.7	72	138.2	102.5	32	186.3	138.2	92	234.5	173.9
53	42.6	31.6	13	90.8	67.3	73	139.0	103.1	33	187.1	138.8	93	235.3	174.5
54	43.4	32.2	14	91.6	67.9	74	139.8	103.7	34	188.0	139.4	94	236.1	175.1
55	44.2	32.8	15	92.4	68.5	75	140.6	104.2	35	188.8	140.0	95	236.9	175.7
56	45.0	33.4	16	93.2	69.1	76	141.4	104.8	36	189.6	140.6	96	237.7	176.3
57	45.8	34.0	17	94.0	69.7	77	142.2	105.4	37	190.4	141.2	97	238.6	176.9
58	46.6	34.6	18	94.8	70.3	78	143.0	106.0	38	191.2	141.8	98	239.4	177.5
59	47.4	35.1	19	95.6	70.9	79	143.8	106.6	39	192.0	142.4	99	240.2	178.1
60	48.2	35.7	20	96.4	71.5	80	144.6	107.2	40	192.8	143.0	300	241.0	178.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.¾E.			S.E.¾E.			N.W.¾W.			S.W.¾W.			[For 4¼ Points.		

TABLE I.

Difference of Latitude and Departure for 3½ Points.

N.E.½N.			N.W.½N.			S.E.½S.			S.W.½S.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.2	38.7	121	93.5	76.8	181	139.9	114.8	241	186.3	152.9
2	01.5	01.3	62	47.9	39.3	22	94.3	77.4	82	140.7	115.5	42	187.1	153.5
3	02.3	01.9	63	48.7	40.0	23	95.1	78.0	83	141.5	116.1	43	187.8	154.2
4	03.1	02.5	64	49.5	40.6	24	95.9	78.7	84	142.2	116.7	44	188.6	154.8
5	03.9	03.2	65	50.2	41.2	25	96.6	79.3	85	143.0	117.4	45	189.4	155.4
6	04.6	03.8	66	51.0	41.9	26	97.4	79.9	86	143.8	118.0	46	190.2	156.1
7	05.4	04.4	67	51.8	42.5	27	98.2	80.6	87	144.6	118.6	47	190.9	156.7
8	06.2	05.1	68	52.6	43.1	28	98.9	81.2	88	145.3	119.3	48	191.7	157.3
9	07.0	05.7	69	53.3	43.8	29	99.7	81.8	89	146.1	119.9	49	192.5	158.0
10	07.7	06.3	70	54.1	44.4	30	100.5	82.5	90	146.9	120.5	50	193.3	158.6
11	08.5	07.0	71	54.9	45.0	131	101.3	83.1	191	147.6	121.2	251	194.0	159.2
12	09.3	07.6	72	55.7	45.7	32	102.0	83.7	92	148.4	121.8	52	194.8	159.9
13	10.0	08.2	73	56.4	46.3	33	102.8	84.4	93	149.2	122.4	53	195.6	160.5
14	10.8	08.9	74	57.2	46.9	34	103.6	85.0	94	150.0	123.1	54	196.3	161.1
15	11.6	09.5	75	58.0	47.6	35	104.4	85.6	95	150.7	123.7	55	197.1	161.8
16	12.4	10.2	76	58.7	48.2	36	105.1	86.3	96	151.5	124.3	56	197.9	162.4
17	13.1	10.8	77	59.5	48.8	37	105.9	86.9	97	152.3	125.0	57	198.7	163.0
18	13.9	11.4	78	60.3	49.5	38	106.7	87.5	98	153.1	125.6	58	199.4	163.7
19	14.7	12.1	79	61.1	50.1	39	107.4	88.2	99	153.8	126.2	59	200.2	164.3
20	15.5	12.7	80	61.8	50.8	40	108.2	88.8	200	154.6	126.9	60	201.0	164.9
21	16.2	13.3	81	62.6	51.4	141	109.0	89.4	201	155.4	127.5	261	201.8	165.6
22	17.0	14.0	82	63.4	52.0	42	109.8	90.1	02	156.1	128.1	62	202.5	166.2
23	17.8	14.6	83	64.2	52.7	43	110.5	90.7	03	156.9	128.8	63	203.3	166.8
24	18.6	15.2	84	64.9	53.3	44	111.3	91.4	04	157.7	129.4	64	204.1	167.5
25	19.3	15.9	85	65.7	53.9	45	112.1	92.0	05	158.5	130.1	65	204.8	168.1
26	20.1	16.5	86	66.5	54.6	46	112.9	92.6	06	159.2	130.7	66	205.6	168.7
27	20.9	17.1	87	67.3	55.2	47	113.6	93.3	07	160.0	131.3	67	206.4	169.4
28	21.6	17.8	88	68.0	55.8	48	114.4	93.9	08	160.8	132.0	68	207.2	170.0
29	22.4	18.4	89	68.8	56.5	49	115.2	94.5	09	161.6	132.6	69	207.9	170.7
30	23.2	19.0	90	69.6	57.1	50	116.0	95.2	10	162.3	133.2	70	208.7	171.3
31	24.0	19.7	91	70.3	57.7	151	116.7	95.8	211	163.1	133.9	271	209.5	171.9
32	24.7	20.3	92	71.1	58.4	52	117.5	96.4	12	163.9	134.5	72	210.3	172.6
33	25.5	20.9	93	71.9	59.0	53	118.3	97.1	13	164.7	135.1	73	211.0	173.2
34	26.3	21.6	94	72.7	59.6	54	119.0	97.7	14	165.4	135.8	74	211.8	173.8
35	27.1	22.2	95	73.4	60.3	55	119.8	98.3	15	166.2	136.4	75	212.6	174.5
36	27.8	22.8	96	74.2	60.9	56	120.6	99.0	16	167.0	137.0	76	213.4	175.1
37	28.6	23.5	97	75.0	61.5	57	121.4	99.6	17	167.7	137.7	77	214.1	175.7
38	29.4	24.1	98	75.8	62.2	58	122.1	100.2	18	168.5	138.3	78	214.9	176.4
39	30.1	24.7	99	76.5	62.8	59	122.9	100.9	19	169.3	138.9	79	215.7	177.0
40	30.9	25.4	100	77.3	63.4	60	123.7	101.5	20	170.1	139.6	80	216.4	177.6
41	31.7	26.0	101	78.1	64.1	161	124.5	102.1	221	170.8	140.2	281	217.2	178.3
42	32.5	26.6	02	78.8	64.7	62	125.2	102.8	22	171.6	140.8	82	218.0	178.9
43	33.2	27.3	03	79.6	65.3	63	126.0	103.4	23	172.4	141.5	83	218.8	179.5
44	34.0	27.9	04	80.4	66.0	64	126.8	104.0	24	173.2	142.1	84	219.5	180.2
45	34.8	28.5	05	81.2	66.6	65	127.5	104.7	25	173.9	142.7	85	220.3	180.8
46	35.6	29.2	06	81.9	67.2	66	128.3	105.3	26	174.7	143.4	86	221.1	181.4
47	36.3	29.8	07	82.7	67.9	67	129.1	105.9	27	175.5	144.0	87	221.9	182.1
48	37.1	30.5	08	83.5	68.5	68	129.9	106.6	28	176.2	144.6	88	222.6	182.7
49	37.9	31.1	09	84.3	69.1	69	130.6	107.2	29	177.0	145.3	89	223.4	183.3
50	38.7	31.7	10	85.0	69.8	70	131.4	107.8	30	177.8	145.9	90	224.2	184.0
51	39.4	32.4	111	85.8	70.4	171	132.2	108.5	231	178.6	146.5	291	224.9	184.6
52	40.2	33.0	12	86.6	71.1	72	133.0	109.1	32	179.3	147.2	92	225.7	185.2
53	41.0	33.6	13	87.4	71.7	73	133.7	109.8	33	180.1	147.8	93	226.5	185.9
54	41.7	34.3	14	88.1	72.3	74	134.5	110.4	34	180.9	148.4	94	227.3	186.5
55	42.5	34.9	15	88.9	73.0	75	135.3	111.0	35	181.7	149.1	95	228.0	187.1
56	43.3	35.5	16	89.7	73.6	76	136.0	111.7	36	182.4	149.7	96	228.8	187.8
57	44.1	36.2	17	90.4	74.2	77	136.8	112.3	37	183.2	150.4	97	229.6	188.4
58	44.8	36.8	18	91.2	74.9	78	137.6	112.9	38	184.0	151.0	98	230.4	189.0
59	45.6	37.4	19	92.0	75.5	79	138.4	113.6	39	184.7	151.6	99	231.1	189.7
60	46.4	38.1	20	92.8	76.1	80	139.1	114.2	40	185.5	152.3	300	231.9	190.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.½E.			S.E.½E.			N.W.½W.			S.W.½W.					

Difference of Latitude and Departure for 3¾ Points.

N.E.¼N.			N.W.¼N.			S.E.¼S.			S.W.¼S.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	45.2	41.0	121	89.7	81.3	181	134.1	121.6	241	178.6	161.8
2	01.5	01.3	62	45.9	41.6	22	90.4	81.9	82	134.9	122.2	42	179.3	162.5
3	02.2	02.0	63	46.7	42.3	23	91.1	82.6	83	135.6	122.9	43	180.1	163.2
4	03.0	02.7	64	47.4	43.0	24	91.9	83.3	84	136.3	123.6	44	180.8	163.9
5	03.7	03.4	65	48.2	43.7	25	92.6	83.9	85	137.1	124.2	45	181.5	164.5
6	04.4	04.0	66	48.9	44.3	26	93.4	84.6	86	137.8	124.9	46	182.3	165.2
7	05.2	04.7	67	49.6	45.0	27	94.1	85.3	87	138.6	125.6	47	183.0	165.9
8	05.9	05.4	68	50.4	45.7	28	94.8	86.0	88	139.3	126.3	48	183.8	166.5
9	06.7	06.0	69	51.1	46.3	29	95.6	86.6	89	140.0	126.9	49	184.5	167.2
10	07.4	06.7	70	51.9	47.0	30	96.3	87.3	90	140.8	127.6	50	185.2	167.9
11	08.2	07.4	71	52.6	47.7	131	97.1	88.0	191	141.5	128.3	251	186.0	168.6
12	08.9	08.1	72	53.3	48.4	32	97.8	88.6	92	142.3	128.9	52	186.7	169.2
13	09.6	08.7	73	54.1	49.0	33	98.5	89.3	93	143.0	129.6	53	187.5	169.9
14	10.4	09.4	74	54.8	49.7	34	99.3	90.0	94	143.7	130.3	54	188.2	170.6
15	11.1	10.1	75	55.6	50.4	35	100.0	90.7	95	144.5	131.0	55	188.9	171.2
16	11.9	10.7	76	56.3	51.0	36	100.8	91.3	96	145.2	131.6	56	189.7	171.9
17	12.6	11.4	77	57.1	51.7	37	101.5	92.0	97	146.0	132.3	57	190.4	172.6
18	13.3	12.1	78	57.8	52.4	38	102.3	92.7	98	146.7	133.0	58	191.2	173.3
19	14.1	12.8	79	58.5	53.1	39	103.0	93.3	99	147.4	133.6	59	191.9	173.9
20	14.8	13.4	80	59.3	53.7	40	103.7	94.0	200	148.2	134.3	60	192.6	174.6
21	15.6	14.1	81	60.0	54.4	141	104.5	94.7	201	148.9	135.0	261	193.4	175.3
22	16.3	14.8	82	60.8	55.1	42	105.2	95.4	02	149.7	135.7	62	194.1	175.9
23	17.0	15.4	83	61.5	55.7	43	106.0	96.0	03	150.4	136.3	63	194.9	176.6
24	17.8	16.1	84	62.2	56.4	44	106.7	96.7	04	151.2	137.0	64	195.6	177.3
25	18.5	16.8	85	63.0	57.1	45	107.4	97.4	05	151.9	137.7	65	196.4	178.0
26	19.3	17.5	86	63.7	57.8	46	108.2	98.0	06	152.6	138.3	66	197.1	178.6
27	20.0	18.1	87	64.5	58.4	47	108.9	98.7	07	153.4	139.0	67	197.8	179.3
28	20.7	18.8	88	65.2	59.1	48	109.7	99.4	08	154.1	139.7	68	198.6	180.0
29	21.5	19.5	89	65.9	59.8	49	110.4	100.1	09	154.9	140.4	69	199.3	180.6
30	22.2	20.1	90	66.7	60.4	50	111.1	100.7	10	155.6	141.0	70	200.1	181.3
31	23.0	20.8	91	67.4	61.1	151	111.9	101.4	211	156.3	141.7	271	200.8	182.0
32	23.7	21.5	92	68.2	61.8	52	112.6	102.1	12	157.1	142.4	72	201.5	182.7
33	24.5	22.2	93	68.9	62.5	53	113.4	102.7	13	157.8	143.0	73	202.3	183.3
34	25.2	22.8	94	69.6	63.1	54	114.1	103.4	14	158.6	143.7	74	203.0	184.0
35	25.9	23.5	95	70.4	63.8	55	114.8	104.1	15	159.3	144.4	75	203.8	184.7
36	26.7	24.2	96	71.1	64.5	56	115.6	104.8	16	160.0	145.1	76	204.5	185.4
37	27.4	24.8	97	71.9	65.1	57	116.3	105.4	17	160.8	145.7	77	205.2	186.0
38	28.2	25.5	98	72.6	65.8	58	117.1	106.1	18	161.5	146.4	78	206.0	186.7
39	28.9	26.2	99	73.4	66.5	59	117.8	106.8	19	162.3	147.1	79	206.7	187.4
40	29.6	26.9	100	74.1	67.2	60	118.6	107.4	20	163.0	147.7	80	207.5	188.0
41	30.4	27.5	101	74.8	67.8	161	119.3	108.1	221	163.8	148.4	281	208.2	188.7
42	31.1	28.2	02	75.6	68.5	62	120.0	108.8	22	164.5	149.1	82	208.9	189.4
43	31.9	28.9	03	76.3	69.2	63	120.8	109.5	23	165.2	149.8	83	209.7	190.1
44	32.6	29.5	04	77.1	69.8	64	121.5	110.1	24	166.0	150.4	84	210.4	190.7
45	33.3	30.2	05	77.8	70.5	65	122.3	110.8	25	166.7	151.1	85	211.2	191.4
46	34.1	30.9	06	78.5	71.2	66	123.0	111.5	26	167.5	151.8	86	211.9	192.1
47	34.8	31.6	07	79.3	71.9	67	123.7	112.2	27	168.2	152.4	87	212.7	192.7
48	35.6	32.2	08	80.0	72.5	68	124.5	112.8	28	168.9	153.1	88	213.4	193.4
49	36.3	32.9	09	80.8	73.2	69	125.2	113.5	29	169.7	153.8	89	214.1	194.1
50	37.0	33.6	10	81.5	73.9	70	126.0	114.2	30	170.4	154.5	90	214.9	194.8
51	37.8	34.2	111	82.2	74.5	171	126.7	114.8	231	171.2	155.1	291	215.6	195.4
52	38.5	34.9	12	83.0	75.2	72	127.4	115.5	32	171.9	155.8	92	216.4	196.1
53	39.3	35.6	13	83.7	75.9	73	128.2	116.2	33	172.6	156.5	93	217.1	196.8
54	40.0	36.3	14	84.5	76.6	74	128.9	116.9	34	173.4	157.1	94	217.8	197.4
55	40.8	36.9	15	85.2	77.2	75	129.7	117.5	35	174.1	157.8	95	218.6	198.1
56	41.5	37.6	16	86.0	77.9	76	130.4	118.2	36	174.9	158.5	96	219.3	198.8
57	42.2	38.3	17	86.7	78.6	77	131.1	118.9	37	175.6	159.2	97	220.1	199.5
58	43.0	39.0	18	87.4	79.2	78	131.9	119.5	38	176.3	159.8	98	220.8	200.1
59	43.7	39.6	19	88.2	79.9	79	132.6	120.2	39	177.1	160.5	99	221.5	200.8
60	44.5	40.3	20	88.9	80.6	80	133.4	120.9	40	177.8	161.2	300	222.3	201.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.¼E.			S.E.¼E.			N.W.¼W.			S.W.¼W.			[For 4¼ Points.		

TABLE I.

Difference of Latitude and Departure for 4 Points.

N.E.			N.W.			S.E.			S.W.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.4	204.4
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
N.E.			N.W.			S.E.			S.W.			[For 4 Points.		

TABLE II.

Difference of Latitude and Departure for 1 Degree.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	01.1	121	121.0	02.1	181	181.0	03.2	241	241.0	04.2
2	02.0	00.0	62	62.0	01.1	22	122.0	02.1	82	182.0	03.2	42	242.0	04.2
3	03.0	00.1	63	63.0	01.1	23	123.0	02.1	83	183.0	03.2	43	243.0	04.2
4	04.0	00.1	64	64.0	01.1	24	124.0	02.2	84	184.0	03.2	44	244.0	04.3
5	05.0	00.1	65	65.0	01.1	25	125.0	02.2	85	185.0	03.2	45	245.0	04.3
6	06.0	00.1	66	66.0	01.2	26	126.0	02.2	86	186.0	03.2	46	246.0	04.3
7	07.0	00.1	67	67.0	01.2	27	127.0	02.2	87	187.0	03.3	47	247.0	04.3
8	08.0	00.1	68	68.0	01.2	28	128.0	02.2	88	188.0	03.3	48	248.0	04.3
9	09.0	00.2	69	69.0	01.2	29	129.0	02.3	89	189.0	03.3	49	249.0	04.3
10	10.0	00.2	70	70.0	01.2	30	130.0	02.3	90	190.0	03.3	50	250.0	04.4
11	11.0	00.2	71	71.0	01.2	131	131.0	02.3	191	191.0	03.3	251	251.0	04.4
12	12.0	00.2	72	72.0	01.3	32	132.0	02.3	92	192.0	03.4	52	252.0	04.4
13	13.0	00.2	73	73.0	01.3	33	133.0	02.3	93	193.0	03.4	53	253.0	04.4
14	14.0	00.2	74	74.0	01.3	34	134.0	02.3	94	194.0	03.4	54	254.0	04.4
15	15.0	00.3	75	75.0	01.3	35	135.0	02.4	95	195.0	03.4	55	255.0	04.5
16	16.0	00.3	76	76.0	01.3	36	136.0	02.4	96	196.0	03.4	56	256.0	04.5
17	17.0	00.3	77	77.0	01.3	37	137.0	02.4	97	197.0	03.4	57	257.0	04.5
18	18.0	00.3	78	78.0	01.4	38	138.0	02.4	98	198.0	03.5	58	258.0	04.5
19	19.0	00.3	79	79.0	01.4	39	139.0	02.4	99	199.0	03.5	59	259.0	04.5
20	20.0	00.3	80	80.0	01.4	40	140.0	02.4	200	200.0	03.5	60	260.0	04.5
21	21.0	00.4	81	81.0	01.4	141	141.0	02.5	201	201.0	03.5	261	261.0	04.6
22	22.0	00.4	82	82.0	01.4	42	142.0	02.5	02	202.0	03.5	62	262.0	04.6
23	23.0	00.4	83	83.0	01.4	43	143.0	02.5	03	203.0	03.5	63	263.0	04.6
24	24.0	00.4	84	84.0	01.5	44	144.0	02.5	04	204.0	03.6	64	264.0	04.6
25	25.0	00.4	85	85.0	01.5	45	145.0	02.5	05	205.0	03.6	65	265.0	04.6
26	26.0	00.5	86	86.0	01.5	46	146.0	02.5	06	206.0	03.6	66	266.0	04.6
27	27.0	00.5	87	87.0	01.5	47	147.0	02.6	07	207.0	03.6	67	267.0	04.7
28	28.0	00.5	88	88.0	01.5	48	148.0	02.6	08	208.0	03.6	68	268.0	04.7
29	29.0	00.5	89	89.0	01.6	49	149.0	02.6	09	209.0	03.6	69	269.0	04.7
30	30.0	00.5	90	90.0	01.6	50	150.0	02.6	10	210.0	03.7	70	270.0	04.7
31	31.0	00.5	91	91.0	01.6	151	151.0	02.6	211	211.0	03.7	271	271.0	04.7
32	32.0	00.6	92	92.0	01.6	52	152.0	02.7	12	212.0	03.7	72	272.0	04.7
33	33.0	00.6	93	93.0	01.6	53	153.0	02.7	13	213.0	03.7	73	273.0	04.8
34	34.0	00.6	94	94.0	01.6	54	154.0	02.7	14	214.0	03.7	74	274.0	04.8
35	35.0	00.6	95	95.0	01.7	55	155.0	02.7	15	215.0	03.8	75	275.0	04.8
36	36.0	00.6	96	96.0	01.7	56	156.0	02.7	16	216.0	03.8	76	276.0	04.8
37	37.0	00.6	97	97.0	01.7	57	157.0	02.7	17	217.0	03.8	77	277.0	04.8
38	38.0	00.7	98	98.0	01.7	58	158.0	02.8	18	218.0	03.8	78	278.0	04.9
39	39.0	00.7	99	99.0	01.7	59	159.0	02.8	19	219.0	03.8	79	279.0	04.9
40	40.0	00.7	100	100.0	01.7	60	160.0	02.8	20	220.0	03.8	80	280.0	04.9
41	41.0	00.7	101	101.0	01.8	161	161.0	02.8	221	221.0	03.9	281	281.0	04.9
42	42.0	00.7	02	102.0	01.8	62	162.0	02.8	22	222.0	03.9	82	282.0	04.9
43	43.0	00.8	03	103.0	01.8	63	163.0	02.8	23	223.0	03.9	83	283.0	04.9
44	44.0	00.8	04	104.0	01.8	64	164.0	02.9	24	224.0	03.9	84	284.0	05.0
45	45.0	00.8	05	105.0	01.8	65	165.0	02.9	25	225.0	03.9	85	285.0	05.0
46	46.0	00.8	06	106.0	01.8	66	166.0	02.9	26	226.0	03.9	86	286.0	05.0
47	47.0	00.8	07	107.0	01.9	67	167.0	02.9	27	227.0	04.0	87	287.0	05.0
48	48.0	00.8	08	108.0	01.9	68	168.0	02.9	28	228.0	04.0	88	288.0	05.0
49	49.0	00.9	09	109.0	01.9	69	169.0	02.9	29	229.0	04.0	89	289.0	05.0
50	50.0	00.9	10	110.0	01.9	70	170.0	03.0	30	230.0	04.0	90	290.0	05.1
51	51.0	00.9	111	111.0	01.9	171	171.0	03.0	231	231.0	04.0	291	291.0	05.1
52	52.0	00.9	12	112.0	02.0	72	172.0	03.0	32	232.0	04.0	92	292.0	05.1
53	53.0	00.9	13	113.0	02.0	73	173.0	03.0	33	233.0	04.1	93	293.0	05.1
54	54.0	00.9	14	114.0	02.0	74	174.0	03.0	34	234.0	04.1	94	294.0	05.1
55	55.0	01.0	15	115.0	02.0	75	175.0	03.1	35	235.0	04.1	95	295.0	05.1
56	56.0	01.0	16	116.0	02.0	76	176.0	03.1	36	236.0	04.1	96	296.0	05.2
57	57.0	01.0	17	117.0	02.0	77	177.0	03.1	37	237.0	04.1	97	297.0	05.2
58	58.0	01.0	18	118.0	02.1	78	178.0	03.1	38	238.0	04.2	98	298.0	05.2
59	59.0	01.0	19	119.0	02.1	79	179.0	03.1	39	239.0	04.2	99	299.0	05.2
60	60.0	01.0	20	120.0	02.1	80	180.0	03.1	40	240.0	04.2	300	300.0	05.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 89 Degrees.

TABLE II.

Difference of Latitude and Departure for 2 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	02.1	121	120.9	04.2	181	180.9	06.3	241	240.9	08.4
2	02.0	00.1	62	62.0	02.2	22	121.9	04.3	82	181.9	06.4	42	241.9	08.4
3	03.0	00.1	63	63.0	02.2	23	122.9	04.3	83	182.9	06.4	43	242.9	08.5
4	04.0	00.1	64	64.0	02.2	24	123.9	04.3	84	183.9	06.4	44	243.9	08.5
5	05.0	00.2	65	65.0	02.3	25	124.9	04.4	85	184.9	06.5	45	244.9	08.6
6	06.0	00.2	66	66.0	02.3	26	125.9	04.4	86	185.9	06.5	46	245.9	08.6
7	07.0	00.2	67	67.0	02.3	27	126.9	04.4	87	186.9	06.5	47	246.8	08.6
8	08.0	00.3	68	68.0	02.4	28	127.9	04.5	88	187.9	06.6	48	247.8	08.7
9	09.0	00.3	69	69.0	02.4	29	128.9	04.5	89	188.9	06.6	49	248.8	08.7
10	10.0	00.3	70	70.0	02.4	30	129.9	04.5	90	189.9	06.6	50	249.8	08.7
11	11.0	00.4	71	71.0	02.5	131	130.9	04.6	191	190.9	06.7	251	250.8	08.8
12	12.0	00.4	72	72.0	02.5	32	131.9	04.6	92	191.9	06.7	52	251.8	08.8
13	13.0	00.5	73	73.0	02.5	33	132.9	04.6	93	192.9	06.7	53	252.8	08.8
14	14.0	00.5	74	74.0	02.6	34	133.9	04.7	94	193.9	06.8	54	253.8	08.9
15	15.0	00.5	75	75.0	02.6	35	134.9	04.7	95	194.9	06.8	55	254.8	08.9
16	16.0	00.6	76	76.0	02.7	36	135.9	04.7	96	195.9	06.8	56	255.8	08.9
17	17.0	00.6	77	77.0	02.7	37	136.9	04.8	97	196.9	06.9	57	256.8	09.0
18	18.0	00.6	78	78.0	02.7	38	137.9	04.8	98	197.9	06.9	58	257.8	09.0
19	19.0	00.7	79	79.0	02.8	39	138.9	04.9	99	198.9	06.9	59	258.8	09.0
20	20.0	00.7	80	80.0	02.8	40	139.9	04.9	200	199.9	07.0	60	259.8	09.1
21	21.0	00.7	81	81.0	02.8	141	140.9	04.9	201	200.9	07.0	261	260.8	09.1
22	22.0	00.8	82	82.0	02.9	42	141.9	05.0	02	201.9	07.0	62	261.8	09.1
23	23.0	00.8	83	82.9	02.9	43	142.9	05.0	03	202.9	07.1	63	262.8	09.2
24	24.0	00.8	84	83.9	02.9	44	143.9	05.0	04	203.9	07.1	64	263.8	09.2
25	25.0	00.9	85	84.9	03.0	45	144.9	05.1	05	204.9	07.2	65	264.8	09.2
26	26.0	00.9	86	85.9	03.0	46	145.9	05.1	06	205.9	07.2	66	265.8	09.3
27	27.0	00.9	87	86.9	03.0	47	146.9	05.1	07	206.9	07.2	67	266.8	09.3
28	28.0	01.0	88	87.9	03.1	48	147.9	05.2	08	207.9	07.3	68	267.8	09.4
29	29.0	01.0	89	88.9	03.1	49	148.9	05.2	09	208.9	07.3	69	268.8	09.4
30	30.0	01.0	90	89.9	03.1	50	149.9	05.2	10	209.9	07.3	70	269.8	09.4
31	31.0	01.1	91	90.9	03.2	151	150.9	05.3	211	210.9	07.4	271	270.8	09.5
32	32.0	01.1	92	91.9	03.2	52	151.9	05.3	12	211.9	07.4	72	271.8	09.5
33	33.0	01.2	93	92.9	03.2	53	152.9	05.3	13	212.9	07.4	73	272.8	09.5
34	34.0	01.2	94	93.9	03.3	54	153.9	05.4	14	213.9	07.5	74	273.8	09.6
35	35.0	01.2	95	94.9	03.3	55	154.9	05.4	15	214.9	07.5	75	274.8	09.6
36	36.0	01.3	96	95.9	03.4	56	155.9	05.4	16	215.9	07.5	76	275.8	09.6
37	37.0	01.3	97	96.9	03.4	57	156.9	05.5	17	216.9	07.6	77	276.8	09.7
38	38.0	01.3	98	97.9	03.4	58	157.9	05.5	18	217.9	07.6	78	277.8	09.7
39	39.0	01.4	99	98.9	03.5	59	158.9	05.5	19	218.9	07.6	79	278.8	09.7
40	40.0	01.4	100	99.9	03.5	60	159.9	05.6	20	219.9	07.7	80	279.8	09.8
41	41.0	01.4	101	100.9	03.5	161	160.9	05.6	221	220.9	07.7	281	280.8	09.8
42	42.0	01.5	02	101.9	03.6	62	161.9	05.7	22	221.9	07.7	82	281.8	09.8
43	43.0	01.5	03	102.9	03.6	63	162.9	05.7	23	222.9	07.8	83	282.8	09.9
44	44.0	01.5	04	103.9	03.6	64	163.9	05.7	24	223.9	07.8	84	283.8	09.9
45	45.0	01.6	05	104.9	03.7	65	164.9	05.8	25	224.9	07.9	85	284.8	09.9
46	46.0	01.6	06	105.9	03.7	66	165.9	05.8	26	225.9	07.9	86	285.8	10.0
47	47.0	01.6	07	106.9	03.7	67	166.9	05.8	27	226.9	07.9	87	286.8	10.0
48	48.0	01.7	08	107.9	03.8	68	167.9	05.9	28	227.9	08.0	88	287.8	10.1
49	49.0	01.7	09	108.9	03.8	69	168.9	05.9	29	228.9	08.0	89	288.8	10.1
50	50.0	01.7	10	109.9	03.8	70	169.9	05.9	30	229.9	08.0	90	289.8	10.1
51	51.0	01.8	111	110.9	03.9	171	170.9	06.0	231	230.9	08.1	291	290.8	10.2
52	52.0	01.8	12	111.9	03.9	72	171.9	06.0	32	231.9	08.1	92	291.8	10.2
53	53.0	01.8	13	112.9	03.9	73	172.9	06.0	33	232.9	08.1	93	292.8	10.2
54	54.0	01.9	14	113.9	04.0	74	173.9	06.1	34	233.9	08.2	94	293.8	10.3
55	55.0	01.9	15	114.9	04.0	75	174.9	06.1	35	234.9	08.2	95	294.8	10.3
56	56.0	02.0	16	115.9	04.0	76	175.9	06.1	36	235.9	08.2	96	295.8	10.3
57	57.0	02.0	17	116.9	04.1	77	176.9	06.2	37	236.9	08.3	97	296.8	10.4
58	58.0	02.0	18	117.9	04.1	78	177.9	06.2	38	237.9	08.3	98	297.8	10.4
59	59.0	02.1	19	118.9	04.2	79	178.9	06.2	39	238.9	08.3	99	298.8	10.4
60	60.0	02.1	20	119.9	04.2	80	179.9	06.3	40	239.9	08.4	300	299.8	10.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 88 Degrees.

Difference of Latitude and Departure for 3 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	03.2	121	120.8	06.3	181	180.8	09.5	241	240.7	12.6
2	02.0	00.1	62	61.9	03.2	22	121.8	06.4	82	181.8	09.5	42	241.7	12.7
3	03.0	00.2	63	62.9	03.3	23	122.8	06.4	83	182.7	09.6	43	242.7	12.7
4	04.0	00.2	64	63.9	03.3	24	123.8	06.5	84	183.7	09.6	44	243.7	12.8
5	05.0	00.3	65	64.9	03.4	25	124.8	06.5	85	184.7	09.7	45	244.7	12.8
6	06.0	00.3	66	65.9	03.5	26	125.8	06.6	86	185.7	09.7	46	245.7	12.9
7	07.0	00.4	67	66.9	03.5	27	126.8	06.6	87	186.7	09.8	47	246.7	12.9
8	08.0	00.4	68	67.9	03.6	28	127.8	06.7	88	187.7	09.8	48	247.7	13.0
9	09.0	00.5	69	68.9	03.6	29	128.8	06.8	89	188.7	09.9	49	248.7	13.0
10	10.0	00.5	70	69.9	03.7	30	129.8	06.8	90	189.7	09.9	50	249.7	13.1
11	11.0	00.6	71	70.9	03.7	131	130.8	06.9	191	190.7	10.0	251	250.7	13.1
12	12.0	00.6	72	71.9	03.8	32	131.8	06.9	92	191.7	10.0	52	251.7	13.2
13	13.0	00.7	73	72.9	03.8	33	132.8	07.0	93	192.7	10.1	53	252.7	13.2
14	14.0	00.7	74	73.9	03.9	34	133.8	07.0	94	193.7	10.2	54	253.7	13.3
15	15.0	00.8	75	74.9	03.9	35	134.8	07.1	95	194.7	10.2	55	254.7	13.3
16	16.0	00.8	76	75.9	04.0	36	135.8	07.1	96	195.7	10.3	56	255.6	13.4
17	17.0	00.9	77	76.9	04.0	37	136.8	07.2	97	196.7	10.3	57	256.6	13.5
18	18.0	00.9	78	77.9	04.1	38	137.8	07.2	98	197.7	10.4	58	257.6	13.5
19	19.0	01.0	79	78.9	04.1	39	138.8	07.3	99	198.7	10.4	59	258.6	13.6
20	20.0	01.0	80	79.9	04.2	40	139.8	07.3	200	199.7	10.5	60	259.6	13.6
21	21.0	01.1	81	80.9	04.2	141	140.8	07.4	201	200.7	10.5	261	260.6	13.7
22	22.0	01.2	82	81.9	04.3	42	141.8	07.4	02	201.7	10.6	62	261.6	13.7
23	23.0	01.2	83	82.9	04.3	43	142.8	07.5	03	202.7	10.6	63	262.6	13.8
24	24.0	01.3	84	83.9	04.4	44	143.8	07.5	04	203.7	10.7	64	263.6	13.8
25	25.0	01.3	85	84.9	04.4	45	144.8	07.6	05	204.7	10.7	65	264.6	13.9
26	26.0	01.4	86	85.9	04.5	46	145.8	07.6	06	205.7	10.8	66	265.6	13.9
27	27.0	01.4	87	86.9	04.6	47	146.8	07.7	07	206.7	10.8	67	266.6	14.0
28	28.0	01.5	88	87.9	04.6	48	147.8	07.7	08	207.7	10.9	68	267.6	14.0
29	29.0	01.5	89	88.9	04.7	49	148.8	07.8	09	208.7	10.9	69	268.6	14.1
30	30.0	01.6	90	89.9	04.7	50	149.8	07.9	10	209.7	11.0	70	269.6	14.1
31	31.0	01.6	91	90.9	04.8	151	150.8	07.9	211	210.7	11.0	271	270.6	14.2
32	32.0	01.7	92	91.9	04.8	52	151.8	08.0	12	211.7	11.1	72	271.6	14.2
33	33.0	01.7	93	92.9	04.9	53	152.8	08.0	13	212.7	11.1	73	272.6	14.3
34	34.0	01.8	94	93.9	04.9	54	153.8	08.1	14	213.7	11.2	74	273.6	14.3
35	35.0	01.8	95	94.9	05.0	55	154.8	08.1	15	214.7	11.3	75	274.6	14.4
36	36.0	01.9	96	95.9	05.0	56	155.8	08.2	16	215.7	11.3	76	275.6	14.4
37	36.9	01.9	97	96.9	05.1	57	156.8	08.2	17	216.7	11.4	77	276.6	14.5
38	37.9	02.0	98	97.9	05.1	58	157.8	08.3	18	217.7	11.4	78	277.6	14.5
39	38.9	02.0	99	98.9	05.2	59	158.8	08.3	19	218.7	11.5	79	278.6	14.6
40	39.9	02.1	100	99.9	05.2	60	159.8	08.4	20	219.7	11.5	80	279.6	14.7
41	40.9	02.1	101	100.9	05.3	161	160.8	08.4	221	220.7	11.6	281	280.6	14.7
42	41.9	02.2	02	101.9	05.3	62	161.8	08.5	22	221.7	11.6	82	281.6	14.8
43	42.9	02.3	03	102.9	05.4	63	162.8	08.5	23	222.7	11.7	83	282.6	14.8
44	43.9	02.3	04	103.9	05.4	64	163.8	08.6	24	223.7	11.7	84	283.6	14.9
45	44.9	02.4	05	104.9	05.5	65	164.8	08.6	25	224.7	11.8	85	284.6	14.9
46	45.9	02.4	06	105.9	05.5	66	165.8	08.7	26	225.7	11.8	86	285.6	15.0
47	46.9	02.5	07	106.9	05.6	67	166.8	08.7	27	226.7	11.9	87	286.6	15.0
48	47.9	02.5	08	107.9	05.7	68	167.8	08.8	28	227.7	11.9	88	287.6	15.1
49	48.9	02.6	09	108.9	05.7	69	168.8	08.8	29	228.7	12.0	89	288.6	15.1
50	49.9	02.6	10	109.8	05.8	70	169.8	08.9	30	229.7	12.0	90	289.6	15.2
51	50.9	02.7	111	110.8	05.8	171	170.8	08.9	231	230.7	12.1	291	290.6	15.2
52	51.9	02.7	12	111.8	05.9	72	171.8	09.0	32	231.7	12.1	92	291.6	15.3
53	52.9	02.8	13	112.8	05.9	73	172.8	09.1	33	232.7	12.2	93	292.6	15.3
54	53.9	02.8	14	113.8	06.0	74	173.8	09.1	34	233.7	12.2	94	293.6	15.4
55	54.9	02.9	15	114.8	06.0	75	174.8	09.2	35	234.7	12.3	95	294.6	15.4
56	55.9	02.9	16	115.8	06.1	76	175.8	09.2	36	235.7	12.4	96	295.6	15.5
57	56.9	03.0	17	116.8	06.1	77	176.8	09.3	37	236.7	12.4	97	296.6	15.5
58	57.9	03.0	18	117.8	06.2	78	177.8	09.3	38	237.7	12.5	98	297.6	15.6
59	58.9	03.1	19	118.8	06.2	79	178.8	09.4	39	238.7	12.5	99	298.6	15.6
60	59.9	03.1	20	119.8	06.3	80	179.8	09.4	40	239.7	12.6	300	299.6	15.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 87 Degrees.

TABLE II.

Difference of Latitude and Departure for 4 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	04.3	121	120.7	08.4	181	180.6	12.6	241	240.4	16.8
2	02.0	00.1	62	61.8	04.3	22	121.7	08.5	82	181.6	12.7	42	241.4	16.9
3	03.0	00.2	63	62.8	04.4	23	122.7	08.6	83	182.6	12.8	43	242.4	17.0
4	04.0	00.3	64	63.8	04.5	24	123.7	08.6	84	183.6	12.8	44	243.4	17.0
5	05.0	00.3	65	64.8	04.5	25	124.7	08.7	85	184.5	12.9	45	244.4	17.1
6	06.0	00.4	66	65.8	04.6	26	125.7	08.8	86	185.5	13.0	46	245.4	17.2
7	07.0	00.5	67	66.8	04.7	27	126.7	08.9	87	186.5	13.0	47	246.4	17.2
8	08.0	00.6	68	67.8	04.7	28	127.7	08.9	88	187.5	13.1	48	247.4	17.3
9	09.0	00.6	69	68.8	04.8	29	128.7	09.0	89	188.5	13.2	49	248.4	17.4
10	10.0	00.7	70	69.8	04.9	30	129.7	09.1	90	189.5	13.3	50	249.4	17.4
11	11.0	00.8	71	70.8	05.0	131	130.7	09.1	191	190.5	13.3	251	250.4	17.5
12	12.0	00.8	72	71.8	05.0	32	131.7	09.2	92	191.5	13.4	52	251.4	17.6
13	13.0	00.9	73	72.8	05.1	33	132.7	09.3	93	192.5	13.5	53	252.4	17.6
14	14.0	01.0	74	73.8	05.2	34	133.7	09.3	94	193.5	13.5	54	253.4	17.7
15	15.0	01.0	75	74.8	05.2	35	134.7	09.4	95	194.5	13.6	55	254.4	17.8
16	16.0	01.1	76	75.8	05.3	36	135.7	09.5	96	195.5	13.7	56	255.4	17.9
17	17.0	01.2	77	76.8	05.4	37	136.7	09.6	97	196.5	13.7	57	256.4	17.9
18	18.0	01.3	78	77.8	05.4	38	137.7	09.6	98	197.5	13.8	58	257.4	18.0
19	19.0	01.3	79	78.8	05.5	39	138.7	09.7	99	198.5	13.9	59	258.4	18.1
20	20.0	01.4	80	79.8	05.6	40	139.7	09.8	200	199.5	14.0	60	259.4	18.1
21	20.9	01.5	81	80.8	05.7	141	140.7	09.8	201	200.5	14.0	261	260.4	18.2
22	21.9	01.5	82	81.8	05.7	42	141.7	09.9	02	201.5	14.1	62	261.4	18.3
23	22.9	01.6	83	82.8	05.8	43	142.7	10.0	03	202.5	14.2	63	262.4	18.3
24	23.9	01.7	84	83.8	05.9	44	143.6	10.0	04	203.5	14.2	64	263.4	18.4
25	24.9	01.7	85	84.8	05.9	45	144.6	10.1	05	204.5	14.3	65	264.4	18.5
26	25.9	01.8	86	85.8	06.0	46	145.6	10.2	06	205.5	14.4	66	265.4	18.6
27	26.9	01.9	87	86.8	06.1	47	146.6	10.3	07	206.5	14.4	67	266.3	18.6
28	27.9	02.0	88	87.8	06.1	48	147.6	10.3	08	207.5	14.5	68	267.3	18.7
29	28.9	02.0	89	88.8	06.2	49	148.6	10.4	09	208.5	14.6	69	268.3	18.8
30	29.9	02.1	90	89.8	06.3	50	149.6	10.5	10	209.5	14.6	70	269.3	18.8
31	30.9	02.2	91	90.8	06.3	151	150.6	10.5	211	210.5	14.7	271	270.3	18.9
32	31.9	02.2	92	91.8	06.4	52	151.6	10.6	12	211.5	14.8	72	271.3	19.0
33	32.9	02.3	93	92.8	06.5	53	152.6	10.7	13	212.5	14.9	73	272.3	19.0
34	33.9	02.4	94	93.8	06.6	54	153.6	10.7	14	213.5	14.9	74	273.3	19.1
35	34.9	02.4	95	94.8	06.6	55	154.6	10.8	15	214.5	15.0	75	274.3	19.2
36	35.9	02.5	96	95.8	06.7	56	155.6	10.9	16	215.5	15.1	76	275.3	19.3
37	36.9	02.6	97	96.8	06.8	57	156.6	11.0	17	216.5	15.1	77	276.3	19.3
38	37.9	02.7	98	97.8	06.8	58	157.6	11.0	18	217.5	15.2	78	277.3	19.4
39	38.9	02.7	99	98.8	06.9	59	158.6	11.1	19	218.5	15.3	79	278.3	19.5
40	39.9	02.8	100	99.8	07.0	60	159.6	11.2	20	219.5	15.3	80	279.3	19.5
41	40.9	02.9	101	100.8	07.0	161	160.6	11.2	221	220.5	15.4	281	280.3	19.6
42	41.9	02.9	02	101.8	07.1	62	161.6	11.3	22	221.5	15.5	82	281.3	19.7
43	42.9	03.0	03	102.7	07.2	63	162.6	11.4	23	222.5	15.6	83	282.3	19.7
44	43.9	03.1	04	103.7	07.3	64	163.6	11.4	24	223.5	15.6	84	283.3	19.8
45	44.9	03.1	05	104.7	07.3	65	164.6	11.5	25	224.5	15.7	85	284.3	19.9
46	45.9	03.2	06	105.7	07.4	66	165.6	11.6	26	225.4	15.8	86	285.3	20.0
47	46.9	03.3	07	106.7	07.5	67	166.6	11.6	27	226.4	15.8	87	286.3	20.0
48	47.9	03.3	08	107.7	07.5	68	167.6	11.7	28	227.4	15.9	88	287.3	20.1
49	48.9	03.4	09	108.7	07.6	69	168.6	11.8	29	228.4	16.0	89	288.3	20.2
50	49.9	03.5	10	109.7	07.7	70	169.6	11.9	30	229.4	16.0	90	289.3	20.2
51	50.9	03.6	111	110.7	07.7	171	170.6	11.9	231	230.4	16.1	291	290.3	20.3
52	51.9	03.6	12	111.7	07.8	72	171.6	12.0	32	231.4	16.2	92	291.3	20.4
53	52.9	03.7	13	112.7	07.9	73	172.6	12.1	33	232.4	16.3	93	292.3	20.4
54	53.9	03.8	14	113.7	08.0	74	173.6	12.1	34	233.4	16.3	94	293.3	20.5
55	54.9	03.8	15	114.7	08.0	75	174.6	12.2	35	234.4	16.4	95	294.3	20.6
56	55.9	03.9	16	115.7	08.1	76	175.6	12.3	36	235.4	16.5	96	295.3	20.6
57	56.9	04.0	17	116.7	08.2	77	176.6	12.3	37	236.4	16.5	97	296.3	20.7
58	57.9	04.0	18	117.7	08.2	78	177.6	12.4	38	237.4	16.6	98	297.3	20.8
59	58.9	04.1	19	118.7	08.3	79	178.6	12.5	39	238.4	16.7	99	298.3	20.9
60	59.9	04.2	20	119.7	08.4	80	179.6	12.6	40	239.4	16.7	300	299.3	20.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 86 Degrees.

Difference of Latitude and Departure for 5 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.8	05.3	121	120.5	10.5	181	180.3	15.8	241	240.1	21.0
2	02.0	00.2	62	61.8	05.4	22	121.5	10.6	82	181.3	15.9	42	241.1	21.1
3	03.0	00.3	63	62.8	05.5	23	122.5	10.7	83	182.3	15.9	43	242.1	21.2
4	04.0	00.3	64	63.8	05.6	24	123.5	10.8	84	183.3	16.0	44	243.1	21.3
5	05.0	00.4	65	64.8	05.7	25	124.5	10.9	85	184.3	16.1	45	244.1	21.4
6	06.0	00.5	66	65.7	05.8	26	125.5	11.0	86	185.3	16.2	46	245.1	21.4
7	07.0	00.6	67	66.7	05.8	27	126.5	11.1	87	186.3	16.3	47	246.1	21.5
8	08.0	00.7	68	67.7	05.9	28	127.5	11.2	88	187.3	16.4	48	247.1	21.6
9	09.0	00.8	69	68.7	06.0	29	128.5	11.2	89	188.3	16.5	49	248.1	21.7
10	10.0	00.9	70	69.7	06.1	30	129.5	11.3	90	189.3	16.6	50	249.0	21.8
11	11.0	01.0	71	70.7	06.2	131	130.5	11.4	191	190.3	16.6	251	250.0	21.9
12	12.0	01.0	72	71.7	06.3	32	131.5	11.5	92	191.3	16.7	52	251.0	22.0
13	13.0	01.1	73	72.7	06.4	33	132.5	11.6	93	192.3	16.8	53	252.0	22.1
14	13.9	01.2	74	73.7	06.4	34	133.5	11.7	94	193.3	16.9	54	253.0	22.1
15	14.9	01.3	75	74.7	06.5	35	134.5	11.8	95	194.3	17.0	55	254.0	22.2
16	15.9	01.4	76	75.7	06.6	36	135.5	11.9	96	195.3	17.1	56	255.0	22.3
17	16.9	01.5	77	76.7	06.7	37	136.5	11.9	97	196.3	17.2	57	256.0	22.4
18	17.9	01.6	78	77.7	06.8	38	137.5	12.0	98	197.2	17.3	58	257.0	22.5
19	18.9	01.7	79	78.7	06.9	39	138.5	12.1	99	198.2	17.3	59	258.0	22.6
20	19.9	01.7	80	79.7	07.0	40	139.5	12.2	200	199.2	17.4	60	259.0	22.7
21	20.9	01.8	81	80.7	07.1	141	140.5	12.3	201	200.2	17.5	261	260.0	22.7
22	21.9	01.9	82	81.7	07.1	42	141.5	12.4	02	201.2	17.6	62	261.0	22.8
23	22.9	02.0	83	82.7	07.2	43	142.5	12.5	03	202.2	17.7	63	262.0	22.9
24	23.9	02.1	84	83.7	07.3	44	143.5	12.6	04	203.2	17.8	64	263.0	23.0
25	24.9	02.2	85	84.7	07.4	45	144.4	12.6	05	204.2	17.9	65	264.0	23.1
26	25.9	02.3	86	85.7	07.5	46	145.4	12.7	06	205.2	18.0	66	265.0	23.2
27	26.9	02.4	87	86.7	07.6	47	146.4	12.8	07	206.2	18.0	67	266.0	23.3
28	27.9	02.4	88	87.7	07.7	48	147.4	12.9	08	207.2	18.1	68	267.0	23.4
29	28.9	02.5	89	88.7	07.8	49	148.4	13.0	09	208.2	18.2	69	268.0	23.4
30	29.9	02.6	90	89.7	07.8	50	149.4	13.1	10	209.2	18.3	70	269.0	23.5
31	30.9	02.7	91	90.7	07.9	151	150.4	13.2	211	210.2	18.4	271	270.0	23.6
32	31.9	02.8	92	91.6	08.0	52	151.4	13.2	12	211.2	18.5	72	271.0	23.7
33	32.9	02.9	93	92.6	08.1	53	152.4	13.3	13	212.2	18.6	73	272.0	23.8
34	33.9	03.0	94	93.6	08.2	54	153.4	13.4	14	213.2	18.7	74	273.0	23.9
35	34.9	03.1	95	94.6	08.3	55	154.4	13.5	15	214.2	18.7	75	274.0	24.0
36	35.9	03.1	96	95.6	08.4	56	155.4	13.6	16	215.2	18.8	76	274.9	24.1
37	36.9	03.2	97	96.6	08.5	57	156.4	13.7	17	216.2	18.9	77	275.9	24.1
38	37.9	03.3	98	97.6	08.5	58	157.4	13.8	18	217.2	19.0	78	276.9	24.2
39	38.9	03.4	99	98.6	08.6	59	158.4	13.9	19	218.2	19.1	79	277.9	24.3
40	39.8	03.5	100	99.6	08.7	60	159.4	13.9	20	219.2	19.2	80	278.9	24.4
41	40.8	03.6	101	100.6	08.8	161	160.4	14.0	221	220.2	19.3	281	279.9	24.5
42	41.8	03.7	02	101.6	08.9	62	161.4	14.1	22	221.2	19.3	82	280.9	24.6
43	42.8	03.7	03	102.6	09.0	63	162.4	14.2	23	222.2	19.4	83	281.9	24.7
44	43.8	03.8	04	103.6	09.1	64	163.4	14.3	24	223.1	19.5	84	282.9	24.8
45	44.8	03.9	05	104.6	09.2	65	164.4	14.4	25	224.1	19.6	85	283.9	24.8
46	45.8	04.0	06	105.6	09.2	66	165.4	14.5	26	225.1	19.7	86	284.9	24.9
47	46.8	04.1	07	106.6	09.3	67	166.4	14.6	27	226.1	19.8	87	285.9	25.0
48	47.8	04.2	08	107.6	09.4	68	167.4	14.6	28	227.1	19.9	88	286.9	25.1
49	48.8	04.3	09	108.6	09.5	69	168.4	14.7	29	228.1	20.0	89	287.9	25.2
50	49.8	04.4	10	109.6	09.6	70	169.4	14.8	30	229.1	20.0	90	288.9	25.3
51	50.8	04.4	111	110.6	09.7	171	170.3	14.9	231	230.1	20.1	291	289.9	25.4
52	51.8	04.5	12	111.6	09.8	72	171.3	15.0	32	231.1	20.2	92	290.9	25.4
53	52.8	04.6	13	112.6	09.8	73	172.3	15.1	33	232.1	20.3	93	291.9	25.5
54	53.8	04.7	14	113.6	09.9	74	173.3	15.2	34	233.1	20.4	94	292.9	25.6
55	54.8	04.8	15	114.6	10.0	75	174.3	15.3	35	234.1	20.5	95	293.9	25.7
56	55.8	04.9	16	115.6	10.1	76	175.3	15.3	36	235.1	20.6	96	294.9	25.8
57	56.8	05.0	17	116.6	10.2	77	176.3	15.4	37	236.1	20.7	97	295.9	25.9
58	57.8	05.1	18	117.6	10.3	78	177.3	15.5	38	237.1	20.7	98	296.9	26.0
59	58.8	05.1	19	118.5	10.4	79	178.3	15.6	39	238.1	20.8	99	297.9	26.1
60	59.8	05.2	20	119.5	10.5	80	179.3	15.7	40	239.1	20.9	300	298.9	26.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 85 Degrees.

TABLE II.

Difference of Latitude and Departure for 6 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.4	121	120.3	12.6	181	180.0	18.9	241	239.7	25.2
2	02.0	00.2	62	61.7	06.5	22	121.3	12.8	82	181.0	19.0	42	240.7	25.3
3	03.0	00.3	63	62.7	06.6	23	122.3	12.9	83	182.0	19.1	43	241.7	25.4
4	04.0	00.4	64	63.6	06.7	24	123.3	13.0	84	183.0	19.2	44	242.7	25.5
5	05.0	00.5	65	64.6	06.8	25	124.3	13.1	85	184.0	19.3	45	243.7	25.6
6	06.0	00.6	66	65.6	06.9	26	125.3	13.2	86	185.0	19.4	46	244.7	25.7
7	07.0	00.7	67	66.6	07.0	27	126.3	13.3	87	186.0	19.5	47	245.6	25.8
8	08.0	00.8	68	67.6	07.1	28	127.3	13.4	88	187.0	19.7	48	246.6	25.9
9	09.0	00.9	69	68.6	07.2	29	128.3	13.5	89	188.0	19.8	49	247.6	26.0
10	09.9	01.0	70	69.6	07.3	30	129.3	13.6	90	189.0	19.9	50	248.6	26.1
11	10.9	01.1	71	70.6	07.4	131	130.3	13.7	191	190.0	20.0	251	249.6	26.2
12	11.9	01.3	72	71.6	07.5	32	131.3	13.8	92	190.9	20.1	52	250.6	26.3
13	12.9	01.4	73	72.6	07.6	33	132.3	13.9	93	191.9	20.2	53	251.6	26.4
14	13.9	01.5	74	73.6	07.7	34	133.3	14.0	94	192.9	20.3	54	252.6	26.6
15	14.9	01.6	75	74.6	07.8	35	134.3	14.1	95	193.9	20.4	55	253.6	26.7
16	15.9	01.7	76	75.6	07.9	36	135.3	14.2	96	194.9	20.5	56	254.6	26.8
17	16.9	01.8	77	76.6	08.0	37	136.2	14.3	97	195.9	20.6	57	255.6	26.9
18	17.9	01.9	78	77.6	08.2	38	137.2	14.4	98	196.9	20.7	58	256.6	27.0
19	18.9	02.0	79	78.6	08.3	39	138.2	14.5	99	197.9	20.8	59	257.6	27.1
20	19.9	02.1	80	79.6	08.4	40	139.2	14.6	200	198.9	20.9	60	258.6	27.2
21	20.9	02.2	81	80.6	08.5	141	140.2	14.7	201	199 9	21.0	261	259.6	27.3
22	21.9	02.3	82	81.6	08.6	42	141.2	14.8	02	200.9	21.1	62	260.6	27.4
23	22.9	02.4	83	82.5	08.7	43	142.2	14.9	03	201.9	21.2	63	261.6	27.5
24	23.9	02.5	84	83.5	08.8	44	143.2	15.1	04	202.9	21.3	64	262.6	27.6
25	24.9	02.6	85	84.5	08.9	45	144.2	15.2	05	203.9	21.4	65	263.5	27.7
26	25.9	02.7	86	85.5	09.0	46	145.2	15.3	06	204.9	21.5	66	264.5	27.8
27	26.9	02.8	87	86.5	09.1	47	146.2	15.4	07	205.9	21.6	67	265.5	27.9
28	27 8	02.9	88	87.5	09.2	48	147.2	15.5	08	206.9	21.7	68	266.5	28.0
29	28.8	03.0	89	88.5	09.3	49	148.2	15.6	09	207.9	21.8	69	267.5	28.1
30	29.8	03.1	90	89.5	09.4	50	149.2	15.7	10	208.8	22.0	70	268.5	28.2
31	30.8	03.2	91	90.5	09.5	151	150.2	15.8	211	209.8	22.1	271	269.5	28.3
32	31.8	03.3	92	91.5	09.6	52	151.2	15.9	12	210.8	22.2	72	270.5	28.4
33	32.8	03.4	93	92.5	09.7	53	152.2	16.0	13	211.8	22.3	73	271.5	28.5
34	33.8	03.6	94	93.5	09.8	54	153.2	16.1	14	212.8	22.4	74	272.5	28.6
35	34.8	03.7	95	94.5	09.9	55	154.2	16.2	15	213.8	22.5	75	273.5	28.7
36	35.8	03.8	96	95.5	10.0	56	155.1	16.3	16	214.8	22.6	76	274.5	28.8
37	36.8	03.9	97	96.5	10.1	57	156.1	16.4	17	215.8	22.7	77	275.5	29.0
38	37.8	04.0	98	97.5	10.2	58	157.1	16.5	18	216.8	22.8	78	276.5	29.1
39	38.8	04.1	99	98.5	10.3	59	158.1	16.6	19	217.8	22.9	79	277.5	29.2
40	39.8	04.2	100	99.5	10.5	60	159.1	16.7	20	218.8	23.0	80	278.5	29.3
41	40.8	04.3	101	100.4	10.6	161	160.1	16.8	221	219.8	23.1	281	279.5	29.4
42	41.8	04.4	02	101.4	10.7	62	161.1	16.9	22	220.8	23.2	82	280.5	29.5
43	42.8	04.5	03	102.4	10.8	63	162.1	17.0	23	221.8	23.3	83	281.4	29.6
44	43.8	04.6	04	103.4	10.9	64	163.1	17.1	24	222.8	23.4	84	282.4	29.7
45	44.8	04.7	05	104.4	11.0	65	164.1	17.2	25	223.8	23.5	85	283.4	29.8
46	45.7	04.8	06	105.4	11.1	66	165.1	17.4	26	224.8	23.6	86	284.4	29.9
47	46.7	04.9	07	106.4	11.2	67	166.1	17.5	27	225.8	23.7	87	285.4	30.0
48	47.7	05.0	08	107.4	11.3	68	167.1	17.6	28	226.8	23.8	88	286.4	30.1
49	48.7	05.1	09	108.4	11.4	69	168.1	17.7	29	227.7	23.9	89	287.4	30.2
50	49.7	05.2	10	109.4	11.5	70	169.1	17.8	30	228.7	24.0	90	288.4	30.3
51	50.7	05.3	111	110.4	11.6	171	170.1	17.9	231	229.7	24.1	291	289.4	30.4
52	51.7	05.4	12	111.4	11.7	72	171.1	18.0	32	230.7	24.3	92	290.4	30.5
53	52.7	05.5	13	112.4	11.8	73	172.1	18.1	33	231.7	24.4	93	291.4	30.6
54	53.7	05.6	14	113.4	11.9	74	173.0	18.2	34	232.7	24.5	94	292.4	30.7
55	54.7	05.7	15	114.4	12.0	75	174.0	18.3	35	233.7	24.6	95	293.4	30.8
56	55.7	05.9	16	115.4	12.1	76	175.0	18.4	36	234.7	24.7	96	294.4	30.9
57	56.7	06.0	17	116.4	12.2	77	176.0	18.5	37	235.7	24.8	97	295.4	31.0
58	57.7	06.1	18	117.4	12.3	78	177.0	18.6	38	236.7	24.9	98	296.4	31.1
59	58.7	06.2	19	118.3	12.4	79	178.0	18.7	39	237.7	25.0	99	297.4	31.3
60	59.7	06.3	20	119.3	12.5	80	179.0	18.8	40	238.7	25.1	300	298.4	31.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 84 Degrees.

Difference of Latitude and Departure for 7 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.5	07.4	121	120.1	14.7	181	179.7	22.1	241	239.2	29.4
2	02.0	00.2	62	61.5	07.6	22	121.1	14.9	82	180.6	22.2	42	240.2	29.5
3	03.0	00.4	63	62.5	07.7	23	122.1	15.0	83	181.6	22.3	43	241.2	29.6
4	04.0	00.5	64	63.5	07.8	24	123.1	15.1	84	182.6	22.4	44	242.2	29.7
5	05.0	00.6	65	64.5	07.9	25	124.1	15.2	85	183.6	22.5	45	243.2	29.9
6	06.0	00.7	66	65.5	08.0	26	125.1	15.4	86	184.6	22.7	46	244.2	30.0
7	06.9	00.9	67	66.5	03.2	27	126.1	15.5	87	185.6	22.8	47	245.2	30.1
8	07.9	01.0	68	67.5	08.3	28	127.0	15.6	88	186.6	22.9	48	246.2	30.2
9	08.9	01.1	69	68.5	08.4	29	128.0	15.7	89	187.6	23.0	49	247.1	30.3
10	09.9	01.2	70	69.5	08.5	30	129.0	15.8	90	188.6	23.2	50	248.1	30.5
11	10.9	01.3	71	70.5	08.7	131	130.0	16.0	191	189.6	23.3	251	249.1	30.6
12	11.9	01.5	72	71.5	08.8	32	131.0	16.1	92	190.6	23.4	52	250.1	30.7
13	12.9	01.6	73	72.5	08.9	33	132.0	16.2	93	191.6	23.5	53	251.1	30.8
14	13.9	01.7	74	73.4	09.0	34	133.0	16.3	94	192.6	23.6	54	252.1	31.0
15	14.9	01.8	75	74.4	09.1	35	134.0	16.5	95	193.5	23.8	55	253.1	31.1
16	15.9	01.9	76	75.4	09.3	36	135.0	16.6	96	194.5	23.9	56	254.1	31.2
17	16.9	02.1	77	76.4	09.4	37	136.0	16.7	97	195.5	24.0	57	255.1	31.3
18	17.9	02.2	78	77.4	09.5	38	137.0	16.8	98	196.5	24.1	58	256.1	31.4
19	18.9	02.3	79	78.4	09.6	39	138.0	16.9	99	197.5	24.3	59	257.1	31.6
20	19.9	02.4	80	79.4	09.7	40	139.0	17.1	200	198.5	24.4	60	258.1	31.7
21	20.8	02.6	81	80.4	09.9	141	139.9	17.2	201	199.5	24.5	261	259.1	31.8
22	21.8	02.7	82	81.4	10.0	42	140.9	17.3	02	200.5	24.6	62	260.0	31.9
23	22.8	02.8	83	82.4	10.1	43	141.9	17.4	03	201.5	24.7	63	261.0	32.1
24	23.8	02.9	84	83.4	10.2	44	142.9	17.5	04	202.5	24.9	64	262.0	32.2
25	24.8	03.0	85	84.4	10.4	45	143.9	17.7	05	203.5	25.0	65	263.0	32.3
26	25.8	03.2	86	85.4	10.5	46	144.9	17.8	06	204.5	25.1	66	264.0	32.4
27	26.8	03.3	87	86.4	10.6	47	145.9	17.9	07	205.5	25.2	67	265.0	32.5
28	27.8	03.4	88	87.3	10.7	48	146.9	18.0	08	206.4	25.3	68	266.0	32.7
29	28.8	03.5	89	88.3	10.8	49	147.9	18.2	09	207.4	25.5	69	267.0	32.8
30	29.8	03.7	90	89.3	11.0	50	148.9	18.3	10	208.4	25.6	70	268.0	32.9
31	30.8	03.8	91	90.3	11.1	151	149.9	18.4	211	209.4	25.7	271	269.0	33.0
32	31.8	03.9	92	91.3	11.2	52	150.9	18.5	12	210.4	25.8	72	270.0	33.1
33	32.8	04.0	93	92.3	11.3	53	151.9	18.6	13	211.4	26.0	73	271.0	33.3
34	33.7	04.1	94	93.3	11.5	54	152.9	18.8	14	212.4	26.1	74	272.0	33.4
35	34.7	04.3	95	94.3	11.6	55	153.8	18.9	15	213.4	26.2	75	273.0	33.5
36	35.7	04.4	96	95.3	11.7	56	154.8	19.0	16	214.4	26.3	76	273.9	33.6
37	36.7	04.5	97	96.3	11.8	57	155.8	19.1	17	215.4	26.4	77	274.9	33.8
38	37.7	04.6	98	97.3	11.9	58	156.8	19.3	18	216.4	26.6	78	275.9	33.9
39	38.7	04.8	99	98.3	12.1	59	157.8	19.4	19	217.4	26.7	79	276.9	34.0
40	39.7	04.9	100	99.3	12.2	60	158.8	19.5	20	218.4	26.8	80	277.9	34.1
41	40.7	05.0	101	100.2	12.3	161	159.8	19.6	221	219.4	26.9	281	278.9	34.2
42	41.7	05.1	02	101.2	12.4	62	160.8	19.7	22	220.3	27.1	82	279.9	34.4
43	42.7	05.2	03	102.2	12.6	63	161.8	19.9	23	221.3	27.2	83	280.9	34.5
44	43.7	05.4	04	103.2	12.7	64	162.8	20.0	24	222.3	27.3	84	281.9	34.6
45	44.7	05.5	05	104.2	12.8	65	163.8	20.1	25	223.3	27.4	85	282.9	34.7
46	45.7	05.6	06	105.2	12.9	66	164.8	20.2	26	224.3	27.5	86	283.9	34.9
47	46.6	05.7	07	106.2	13.0	67	165.8	20.4	27	225.3	27.7	87	284.9	35.0
48	47.6	05.8	08	107.2	13.2	68	166.7	20.5	28	226.3	27.8	88	285.9	35.1
49	48.6	06.0	09	108.2	13.3	69	167.7	20.6	29	227.3	27.9	89	286.8	35.2
50	49.6	06.1	10	109.2	13.4	70	168.7	20.7	30	228.3	28.0	90	287.8	35.3
51	50.6	06.2	111	110.2	13.5	171	169.7	20.8	231	229.3	28.2	291	288.8	35.5
52	51.6	06.3	12	111.2	13.6	72	170.7	21.0	32	230.3	28.3	92	289.8	35.6
53	52.6	06.5	13	112.2	13.8	73	171.7	21.1	33	231.3	28.4	93	290.8	35.7
54	53.6	06.6	14	113.2	13.9	74	172.7	21.2	34	232.3	28.5	94	291.8	35.8
55	54.6	06.7	15	114.1	14.0	75	173.7	21.3	35	233.2	28.6	95	292.8	36.0
56	55.6	06.8	16	115.1	14.1	76	174.7	21.4	36	234.2	28.8	96	293.8	36.1
57	56.6	06.9	17	116.1	14.3	77	175.7	21.6	37	235.2	28.9	97	294.8	36.2
58	57.6	07.1	18	117.1	14.4	78	176.7	21.7	38	236.2	29.0	98	295.8	36.3
59	58.6	07.2	19	118.1	14.5	79	177.7	21.8	39	237.2	29.1	99	296.8	36.4
60	59.6	07.3	20	119.1	14.6	80	178.7	21.9	40	238.2	29.2	300	297.8	36.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

Difference of Latitude and Departure for 8 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.4	08.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	02.0	00.3	62	61.4	08.6	22	120.8	17.0	82	180.2	25.3	42	239.6	33.7
3	03.0	00.4	63	62.4	08.8	23	121.8	17.1	83	181.2	25.5	43	240.6	33.8
4	04.0	00.6	64	63.4	08.9	24	122.8	17.3	84	182.2	25.6	44	241.6	34.0
5	05.0	00.7	65	64.4	09.0	25	123.8	17.4	85	183.2	25.7	45	242.6	34.1
6	05.9	00.8	66	65.4	09.2	26	124.8	17.5	86	184.2	25.9	46	243.6	34.2
7	06.9	01.0	67	66.3	09.3	27	125.8	17.7	87	185.2	26.0	47	244.6	34.4
8	07.9	01.1	68	67.3	09.5	28	126.8	17.8	88	186.2	26.2	48	245.6	34.5
9	08.9	01.3	69	68.3	09.6	29	127.7	18.0	89	187.2	26.3	49	246.6	34.7
10	09.9	01.4	70	69.3	09.7	30	128.7	18.1	90	188.2	26.4	50	247.6	34.8
11	10.9	01.5	71	70.3	09.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	01.7	72	71.3	10.0	32	130.7	18.4	92	190.1	26.7	52	249.5	35.1
13	12.9	01.8	73	72.3	10.2	33	131.7	18.5	93	191.1	26.9	53	250.5	35.2
14	13.9	01.9	74	73.3	10.3	34	132.7	18.6	94	192.1	27.0	54	251.5	35.3
15	14.9	02.1	75	74.3	10.4	35	133.7	18.8	95	193.1	27.1	55	252.5	35.5
16	15.8	02.2	76	75.3	10.6	36	134.7	18.9	96	194.1	27.3	56	253.5	35.6
17	16.8	02.4	77	76.3	10.7	37	135.7	19.1	97	195.1	27.4	57	254.5	35.8
18	17.8	02.5	78	77.2	10.9	38	136.7	19.2	98	196.1	27.6	58	255.5	35.9
19	18.8	02.6	79	78.2	11.0	39	137.7	19.3	99	197.1	27.7	59	256.5	36.0
20	19.8	02.8	80	79.2	11.1	40	138.6	19.5	200	198.1	27.8	60	257.5	36.2
21	20.8	02.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	03.1	82	81.2	11.4	42	140.6	19.8	02	200.0	28.1	62	259.5	36.5
23	22.8	03.2	83	82.2	11.6	43	141.6	19.9	03	201.0	28.3	63	260.4	36.6
24	23.8	03.3	84	83.2	11.7	44	142.6	20.0	04	202.0	28.4	64	261.4	36.7
25	24.8	03.5	85	84.2	11.8	45	143.6	20.2	05	203.0	28.5	65	262.4	36.9
26	25.7	03.6	86	85.2	12.0	46	144.6	20.3	06	204.0	28.7	66	263.4	37.0
27	26.7	03.8	87	86.2	12.1	47	145.6	20.5	07	205.0	28.8	67	264.4	37.2
28	27.7	03.9	88	87.1	12.2	48	146.6	20.6	08	206.0	28.9	68	265.4	37.3
29	28.7	04.0	89	88.1	12.4	49	147.5	20.7	09	207.0	29.1	69	266.4	37.4
30	29.7	04.2	90	89.1	12.5	50	148.5	20.9	10	208.0	29.2	70	267.4	37.6
31	30.7	04.3	91	90.1	12.7	151	149.5	21.0	211	208.9	29.4	271	268.4	37.7
32	31.7	04.5	92	91.1	12.8	52	150.5	21.2	12	209.9	29.5	72	269.4	37.9
33	32.7	04.6	93	92.1	12.9	53	151.5	21.3	13	210.9	29.6	73	270.3	38.0
34	33.7	04.7	94	93.1	13.1	54	152.5	21.4	14	211.9	29.8	74	271.3	38.1
35	34.7	04.9	95	94.1	13.2	55	153.5	21.6	15	212.9	29.9	75	272.3	38.3
36	35.6	05.0	96	95.1	13.4	56	154.5	21.7	16	213.9	30.1	76	273.3	38.4
37	36.6	05.1	97	96.1	13.5	57	155.5	21.9	17	214.9	30.2	77	274.3	38.6
38	37.6	05.3	98	97.0	13.6	58	156.5	22.0	18	215.9	30.3	78	275.3	38.7
39	38.6	05.4	99	98.0	13.8	59	157.5	22.1	19	216.9	30.5	79	276.3	38.8
40	39.6	05.6	100	99.0	13.9	60	158.4	22.3	20	217.9	30.6	80	277.3	39.0
41	40.6	05.7	101	100.0	14.1	161	159.4	22.4	221	218.8	30.8	281	278.3	39.1
42	41.6	05.8	02	101.0	14.2	62	160.4	22.5	22	219.8	30.9	82	279.3	39.2
43	42.6	06.0	03	102.0	14.3	63	161.4	22.7	23	220.8	31.0	83	280.2	39.4
44	43.6	06.1	04	103.0	14.5	64	162.4	22.8	24	221.8	31.2	84	281.2	39.5
45	44.6	06.3	05	104.0	14.6	65	163.4	23.0	25	222.8	31.3	85	282.2	39.7
46	45.6	06.4	06	105.0	14.8	66	164.4	23.1	26	223.8	31.5	86	283.2	39.8
47	46.5	06.5	07	106.0	14.9	67	165.4	23.2	27	224.8	31.6	87	284.2	39.9
48	47.5	06.7	08	106.9	15.0	68	166.4	23.4	28	225.8	31.7	88	285.2	40.1
49	48.5	06.8	09	107.9	15.2	69	167.4	23.5	29	226.8	31.9	89	286.2	40.2
50	49.5	07.0	110	108.9	15.3	70	168.3	23.7	30	227.8	32.0	90	287.2	40.4
51	50.5	07.1	111	109.9	15.4	171	169.3	23.8	231	228.8	32.1	291	288.2	40.5
52	51.5	07.2	12	110.9	15.6	72	170.3	23.9	32	229.7	32.3	92	289.2	40.6
53	52.5	07.4	13	111.9	15.7	73	171.3	24.1	33	230.7	32.4	93	290.1	40.8
54	53.5	07.5	14	112.9	15.9	74	172.3	24.2	34	231.7	32.6	94	291.1	40.9
55	54.5	07.7	15	113.9	16.0	75	173.3	24.4	35	232.7	32.7	95	292.1	41.1
56	55.5	07.8	16	114.9	16.1	76	174.3	24.5	36	233.7	32.8	96	293.1	41.2
57	56.4	07.9	17	115.9	16.3	77	175.3	24.6	37	234.7	33.0	97	294.1	41.3
58	57.4	08.1	18	116.9	16.4	78	176.3	24.8	38	235.7	33.1	98	295.1	41.5
59	58.4	08.2	19	117.8	16.6	79	177.3	24.9	39	236.7	33.3	99	296.1	41.6
60	59.4	08.4	20	118.8	16.7	80	178.2	25.1	40	237.7	33.4	300	297.1	41.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 82 Degrees.

Difference of Latitude and Departure for 9 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	60.2	09.5	121	119.5	18.9	181	178.8	28.3	241	238.0	37.7
2	02.0	00.3	62	61.2	09.7	22	120.5	19.1	82	179.8	28.5	42	239.0	37.9
3	03.0	00.5	63	62.2	09.9	23	121.5	19.2	83	180.7	28.6	43	240.0	38.0
4	04.0	00.6	64	63.2	10.0	24	122.5	19.4	84	181.7	28.8	44	241.0	38.2
5	04.9	00.8	65	64.2	10.2	25	123.5	19.6	85	182.7	28.9	45	242.0	38.3
6	05.9	00.9	66	65.2	10.3	26	124.4	19.7	86	183.7	29.1	46	243.0	38.5
7	06.9	01.1	67	66.2	10.5	27	125.4	19.9	87	184.7	29.3	47	244.0	38.6
8	07.9	01.3	68	67.2	10.6	28	126.4	20.0	88	185.7	29.4	48	244.9	38.8
9	08.9	01.4	69	68.2	10.8	29	127.4	20.2	89	186.7	29.6	49	245.9	39.0
10	09.9	01.6	70	69.1	11.0	30	128.4	20.3	90	187.7	29.7	50	246.9	39.1
11	10.9	01.7	71	70.1	11.1	131	129.4	20.5	191	188.6	29.9	251	247.9	39.3
12	11.9	01.9	72	71.1	11.3	32	130.4	20.6	92	189.6	30.0	52	248.9	39.4
13	12.8	02.0	73	72.1	11.4	33	131.4	20.8	93	190.6	30.2	53	249.9	39.6
14	13.8	02.2	74	73.1	11.6	34	132.4	21.0	94	191.6	30.3	54	250.9	39.7
15	14.8	02.3	75	74.1	11.7	35	133.3	21.1	95	192.6	30.5	55	251.9	39.9
16	15.8	02.5	76	75.1	11.9	36	134.3	21.3	96	193.6	30.7	56	252.8	40.0
17	16.8	02.7	77	76.1	12.0	37	135.3	21.4	97	194.6	30.8	57	253.8	40.2
18	17.8	02.8	78	77.0	12.2	38	136.3	21.6	98	195.6	31.0	58	254.8	40.4
19	18.8	03.0	79	78.0	12.4	39	137.3	21.7	99	196.5	31.1	59	255.8	40.5
20	19.8	03.1	80	79.0	12.5	40	138.3	21.9	200	197.5	31.3	60	256.8	40.7
21	20.7	03.3	81	80.0	12.7	141	139.3	22.1	201	198.5	31.4	261	257.8	40.8
22	21.7	03.4	82	81.0	12.8	42	140.3	22.2	02	199.5	31.6	62	258.8	41.0
23	22.7	03.6	83	82.0	13.0	43	141.2	22.4	03	200.5	31.8	63	259.8	41.1
24	23.7	03.8	84	83.0	13.1	44	142.2	22.5	04	201.5	31.9	64	260.7	41.3
25	24.7	03.9	85	84.0	13.3	45	143.2	22.7	05	202.5	32.1	65	261.7	41.5
26	25.7	04.1	86	84.9	13.5	46	144.2	22.8	06	203.5	32.2	66	262.7	41.6
27	26.7	04.2	87	85.9	13.6	47	145.2	23.0	07	204.5	32.4	67	263.7	41.8
28	27.7	04.4	88	86.9	13.8	48	146.2	23.2	08	205.4	32.5	68	264.7	41.9
29	28.6	04.5	89	87.9	13.9	49	147.2	23.3	09	206.4	32.7	69	265.7	42.1
30	29.6	04.7	90	88.9	14.1	50	148.2	23.5	10	207.4	32.9	70	266.7	42.2
31	30.6	04.8	91	89.9	14.2	151	149.1	23.6	211	208.4	33.0	271	267.7	42.4
32	31.6	05.0	92	90.9	14.4	52	150.1	23.8	12	209.4	33.2	72	268.7	42.6
33	32.6	05.2	93	91.9	14.5	53	151.1	23.9	13	210.4	33.3	73	269.6	42.7
34	33.6	05.3	94	92.8	14.7	54	152.1	24.1	14	211.4	33.5	74	270.6	42.9
35	34.6	05.5	95	93.8	14.9	55	153.1	24.2	15	212.4	33.6	75	271.6	43.0
36	35.6	05.6	96	94.8	15.0	56	154.1	24.4	16	213.3	33.8	76	272.6	43.2
37	36.5	05.8	97	95.8	15.2	57	155.1	24.6	17	214.3	33.9	77	273.6	43.3
38	37.5	05.9	98	96.8	15.3	58	156.1	24.7	18	215.3	34.1	78	274.6	43.5
39	38.5	06.1	99	97.8	15.5	59	157.0	24.9	19	216.3	34.3	79	275.6	43.6
40	39.5	06.3	100	98.8	15.6	60	158.0	25.0	20	217.3	34.4	80	276.6	43.8
41	40.5	06.4	101	99.8	15.8	161	159.0	25.2	221	218.3	34.6	281	277.5	44.0
42	41.5	06.6	02	100.7	16.0	62	160.0	25.3	22	219.3	34.7	82	278.5	44.1
43	42.5	06.7	03	101.7	16.1	63	161.0	25.5	23	220.3	34.9	83	279.5	44.3
44	43.5	06.9	04	102.7	16.3	64	162.0	25.7	24	221.2	35.0	84	280.5	44.4
45	44.4	07.0	05	103.7	16.4	65	163.0	25.8	25	222.2	35.2	85	281.5	44.6
46	45.4	07.2	06	104.7	16.6	66	164.0	26.0	26	223.2	35.4	86	282.5	44.7
47	46.4	07.4	07	105.7	16.7	67	164.9	26.1	27	224.2	35.5	87	283.5	44.9
48	47.4	07.5	08	106.7	16.9	68	165.9	26.3	28	225.2	35.7	88	284.5	45.1
49	48.4	07.7	09	107.7	17.1	69	166.9	26.4	29	226.2	35.8	89	285.4	45.2
50	49.4	07.8	10	108.6	17.2	70	167.9	26.6	30	227.2	36.0	90	286.4	45.4
51	50.4	08.0	111	109.6	17.4	171	168.9	26.8	231	228.2	36.1	291	287.4	45.5
52	51.4	08.1	12	110.6	17.5	72	169.9	26.9	32	229.1	36.3	92	288.4	45.7
53	52.3	08.3	13	111.6	17.7	73	170.9	27.1	33	230.1	36.4	93	289.4	45.8
54	53.3	08.4	14	112.6	17.8	74	171.9	27.2	34	231.1	36.6	94	290.4	46.0
55	54.3	08.6	15	113.6	18.0	75	172.8	27.4	35	232.1	36.8	95	291.4	46.1
56	55.3	08.8	16	114.6	18.1	76	173.8	27.5	36	233.1	36.9	96	292.4	46.3
57	56.3	08.9	17	115.6	18.3	77	174.8	27.7	37	234.1	37.1	97	293.3	46.5
58	57.3	09.1	18	116.5	18.5	78	175.8	27.8	38	235.1	37.2	98	294.3	46.6
59	58.3	09.2	19	117.5	18.6	79	176.8	28.0	39	236.1	37.4	99	295.3	46.8
60	59.3	09.4	20	118.5	18.8	80	177.8	28.2	40	237.0	37.5	300	296.3	46.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 81 Degrees.

Difference of Latitude and Departure for 10 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	60.1	10.6	121	119.2	21.0	181	178.3	31.4	241	237.3	41.8
2	02.0	00.3	62	61.1	10.8	22	120.1	21.2	82	179.2	31.6	42	238.3	42.0
3	03.0	00.5	63	62.0	10.9	23	121.1	21.4	83	180.2	31.8	43	239.3	42.2
4	03.9	00.7	64	63.0	11.1	24	122.1	21.5	84	181.2	32.0	44	240.3	42.4
5	04.9	00.9	65	64.0	11.3	25	123.1	21.7	85	182.2	32.1	45	241.3	42.5
6	05.9	01.0	66	65.0	11.5	26	124.1	21.9	86	183.2	32.3	46	242.3	42.7
7	06.9	01.2	67	66.0	11.6	27	125.1	22.1	87	184.2	32.5	47	243.2	42.9
8	07.9	01.4	68	67.0	11.8	28	126.1	22.2	88	185.1	32.6	48	244.2	43.1
9	08.9	01.6	69	68.0	12.0	29	127.0	22.4	89	186.1	32.8	49	245.2	43.2
10	09.8	01.7	70	68.9	12.2	30	128.0	22.6	90	187.1	33.0	50	246.2	43.4
11	10.8	01.9	71	69.9	12.3	131	129.0	22.7	191	188.1	33.2	251	247.2	43.6
12	11.8	02.1	72	70.9	12.5	32	130.0	22.9	92	189.1	33.3	52	248.2	43.8
13	12.8	02.3	73	71.9	12.7	33	131.0	23.1	93	190.1	33.5	53	249.2	43.9
14	13.8	02.4	74	72.9	12.8	34	132.0	23.3	94	191.1	33.7	54	250.1	44.1
15	14.8	02.6	75	73.9	13.0	35	132.9	23.4	95	192.0	33.9	55	251.1	44.3
16	15.8	02.8	76	74.8	13.2	36	133.9	23.6	96	193.0	34.0	56	252.1	44.5
17	16.7	03.0	77	75.8	13.4	37	134.9	23.8	97	194.0	34.2	57	253.1	44.6
18	17.7	03.1	78	76.8	13.5	38	135.9	24.0	98	195.0	34.4	58	254.1	44.8
19	18.7	03.3	79	77.8	13.7	39	136.9	24.1	99	196.0	34.6	59	255.1	45.0
20	19.7	03.5	80	78.8	13.9	40	137.9	24.3	200	197.0	34.7	60	256.1	45.1
21	20.7	03.6	81	79.8	14.1	141	138.9	24.5	201	197.9	34.9	261	257.0	45.3
22	21.7	03.8	82	80.8	14.2	42	139.8	24.7	02	198.9	35.1	62	258.0	45.5
23	22.7	04.0	83	81.7	14.4	43	140.8	24.8	03	199.9	35.3	63	259.0	45.7
24	23.6	04.2	84	82.7	14.6	44	141.8	25.0	04	200.9	35.4	64	260.0	45.8
25	24.6	04.3	85	83.7	14.8	45	142.8	25.2	05	201.9	35.6	65	261.0	46.0
26	25.6	04.5	86	84.7	14.9	46	143.8	25.4	06	202.9	35.8	66	262.0	46.2
27	26.6	04.7	87	85.7	15.1	47	144.8	25.5	07	203.9	35.9	67	262.9	46.4
28	27.6	04.9	88	86.7	15.3	48	145.8	25.7	08	204.8	36.1	68	263.9	46.5
29	28.6	05.0	89	87.6	15.5	49	146.7	25.9	09	205.8	36.3	69	264.9	46.7
30	29.5	05.2	90	88.6	15.6	50	147.7	26.0	10	206.8	36.5	70	265.9	46.9
31	30.5	05.4	91	89.6	15.8	151	148.7	26.2	211	207.8	36.6	271	266.9	47.1
32	31.5	05.6	92	90.6	16.0	52	149.7	26.4	12	208.8	36.8	72	267.9	47.2
33	32.5	05.7	93	91.6	16.1	53	150.7	26.6	13	209.8	37.0	73	268.9	47.4
34	33.5	05.9	94	92.6	16.3	54	151.7	26.7	14	210.7	37.2	74	269.8	47.6
35	34.5	06.1	95	93.6	16.5	55	152.6	26.9	15	211.7	37.3	75	270.8	47.8
36	35.5	06.3	96	94.5	16.7	56	153.6	27.1	16	212.7	37.5	76	271.8	47.9
37	36.4	06.4	97	95.5	16.8	57	154.6	27.3	17	213.7	37.7	77	272.8	48.1
38	37.4	06.6	98	96.5	17.0	58	155.6	27.4	18	214.7	37.9	78	273.8	48.3
39	38.4	06.8	99	97.5	17.2	59	156.6	27.6	19	215.7	38.0	79	274.8	48.4
40	39.4	06.9	100	98.5	17.4	60	157.6	27.8	20	216.7	38.2	80	275.7	48.6
41	40.4	07.1	101	99.5	17.5	161	158.6	28.0	221	217.6	38.4	281	276.7	48.8
42	41.4	07.3	02	100.5	17.7	62	159.5	28.1	22	218.6	38.5	82	277.7	49.0
43	42.3	07.5	03	101.4	17.9	63	160.5	28.3	23	219.6	38.7	83	278.7	49.1
44	43.3	07.6	04	102.4	18.1	64	161.5	28.5	24	220.6	38.9	84	279.7	49.3
45	44.3	07.8	05	103.4	18.2	65	162.5	28.7	25	221.6	39.1	85	280.7	49.5
46	45.3	08.0	06	104.4	18.4	66	163.5	28.8	26	222.6	39.2	86	281.7	49.7
47	46.3	08.2	07	105.4	18.6	67	164.5	29.0	27	223.6	39.4	87	282.6	49.8
48	47.3	08.3	08	106.4	18.8	68	165.4	29.2	28	224.5	39.6	88	283.6	50.0
49	48.3	08.5	09	107.3	18.9	69	166.4	29.3	29	225.5	39.8	89	284.6	50.2
50	49.2	08.7	10	108.3	19.1	70	167.4	29.5	30	226.5	39.9	90	285.6	50.4
51	50.2	08.9	111	109.3	19.3	171	168.4	29.7	231	227.5	40.1	291	286.6	50.5
52	51.2	09.0	12	110.3	19.4	72	169.4	29.9	32	228.5	40.3	92	287.6	50.7
53	52.2	09.2	13	111.3	19.6	73	170.4	30.0	33	229.5	40.5	93	288.5	50.9
54	53.2	09.4	14	112.3	19.8	74	171.4	30.2	34	230.4	40.6	94	289.5	51.1
55	54.2	09.6	15	113.3	20.0	75	172.3	30.4	35	231.4	40.8	95	290.5	51.2
56	55.1	09.7	16	114.2	20.1	76	173.3	30.6	36	232.4	41.0	96	291.5	51.4
57	56.1	09.9	17	115.2	20.3	77	174.3	30.7	37	233.4	41.2	97	292.5	51.6
58	57.1	10.1	18	116.2	20.5	78	175.3	30.9	38	234.4	41.3	98	293.5	51.7
59	58.1	10.2	19	117.2	20.7	79	176.3	31.1	39	235.4	41.5	99	294.5	51.9
60	59.1	10.4	20	118.2	20.8	80	177.3	31.3	40	236.4	41.7	300	295.4	52.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 80 Degrees.

TABLE II.

Difference of Latitude and Departure for 11 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.9	11.6	121	118.8	23.1	181	177.7	34.5	241	236.6	46.0
2	02.0	00.4	62	60.9	11.8	22	119.8	23.3	82	178.7	34.7	42	237.6	46.2
3	02.9	00.6	63	61.8	12.0	23	120.7	23.5	83	179.6	34.9	43	238.5	46.4
4	03.9	00.8	64	62.8	12.2	24	121.7	23.7	84	180.6	35.1	44	239.5	46.6
5	04.9	01.0	65	63.8	12.4	25	122.7	23.9	85	181.6	35.3	45	240.5	46.7
6	05.9	01.1	66	64.8	12.6	26	123.7	24.0	86	182.6	35.5	46	241.5	46.9
7	06.9	01.3	67	65.8	12.8	27	124.7	24.2	87	183.6	35.7	47	242.5	47.1
8	07.9	01.5	68	66.8	13.0	28	125.6	24.4	88	184.5	35.9	48	243.4	47.3
9	08.8	01.7	69	67.7	13.2	29	126.6	24.6	89	185.5	36.1	49	244.4	47.5
10	09.8	01.9	70	68.7	13.4	30	127.6	24.8	90	186.5	36.3	50	245.4	47.7
11	10.8	02.1	71	69.7	13.5	131	128.6	25.0	191	187.5	36.4	251	246.4	47.9
12	11.8	02.3	72	70.7	13.7	32	129.6	25.2	92	188.5	36.6	52	247.4	48.1
13	12.8	02.5	73	71.7	13.9	33	130.6	25.4	93	189.5	36.8	53	248.4	48.3
14	13.7	02.7	74	72.6	14.1	34	131.5	25.6	94	190.4	37.0	54	249.3	48.5
15	14.7	02.9	75	73.6	14.3	35	132.5	25.8	95	191.4	37.2	55	250.3	48.7
16	15.7	03.1	76	74.6	14.5	36	133.5	26.0	96	192.4	37.4	56	251.3	48.8
17	16.7	03.2	77	75.6	14.7	37	134.5	26.1	97	193.4	37.6	57	252.3	49.0
18	17.7	03.4	78	76.6	14.9	38	135.5	26.3	98	194.4	37.8	58	253.3	49.2
19	18.7	03.6	79	77.5	15.1	39	136.4	26.5	99	195.3	38.0	59	254.2	49.4
20	19.6	03.8	80	78.5	15.3	40	137.4	26.7	200	196.3	38.2	60	255.2	49.6
21	20.6	04.0	81	79.5	15.5	141	138.4	26.9	201	197.3	38.4	261	256.2	49.8
22	21.6	04.2	82	80.5	15.6	42	139.4	27.1	02	198.3	38.5	62	257.2	50.0
23	22.6	04.4	83	81.5	15.8	43	140.4	27.3	03	199.3	38.7	63	258.2	50.2
24	23.6	04.6	84	82.5	16.0	44	141.4	27.5	04	200.3	38.9	64	259.1	50.4
25	24.5	04.8	85	83.4	16.2	45	142.3	27.7	05	201.2	39.1	65	260.1	50.6
26	25.5	05.0	86	84.4	16.4	46	143.3	27.9	06	202.2	39.3	66	261.1	50.8
27	26.5	05.2	87	85.4	16.6	47	144.3	28.0	07	203.2	39.5	67	262.1	50.9
28	27.5	05.3	88	86.4	16.8	48	145.3	28.2	08	204.2	39.7	68	263.1	51.1
29	28.5	05.5	89	87.4	17.0	49	146.3	28.4	09	205.2	39.9	69	264.1	51.3
30	29.4	05.7	90	88.3	17.2	50	147.2	28.6	10	206.1	40.1	70	265.0	51.5
31	30.4	05.9	91	89.3	17.4	151	148.2	28.8	211	207.1	40.3	271	266.0	51.7
32	31.4	06.1	92	90.3	17.6	52	149.2	29.0	12	208.1	40.5	72	267.0	51.9
33	32.4	06.3	93	91.3	17.7	53	150.2	29.2	13	209.1	40.6	73	268.0	52.1
34	33.4	06.5	94	92.3	17.9	54	151.2	29.4	14	210.1	40.8	74	269.0	52.3
35	34.4	06.7	95	93.3	18.1	55	152.2	29.6	15	211.0	41.0	75	269.9	52.5
36	35.3	06.9	96	94.2	18.3	56	153.1	29.8	16	212.0	41.2	76	270.9	52.7
37	36.3	07.1	97	95.2	18.5	57	154.1	30.0	17	213.0	41.4	77	271.9	52.9
38	37.3	07.3	98	96.2	18.7	58	155.1	30.1	18	214.0	41.6	78	272.9	53.0
39	38.3	07.4	99	97.2	18.9	59	156.1	30.3	19	215.0	41.8	79	273.9	53.2
40	39.3	07.6	100	98.2	19.1	60	157.1	30.5	20	216.0	42.0	80	274.9	53.4
41	40.2	07.8	101	99.1	19.3	161	158.0	30.7	221	216.9	42.2	281	275.8	53.6
42	41.2	08.0	02	100.1	19.5	62	159.0	30.9	22	217.9	42.4	82	276.8	53.8
43	42.2	08.2	03	101.1	19.7	63	160.0	31.1	23	218.9	42.6	83	277.8	54.0
44	43.2	08.4	04	102.1	19.8	64	161.0	31.3	24	219.9	42.7	84	278.8	54.2
45	44.2	08.6	05	103.1	20.0	65	162.0	31.5	25	220.9	42.9	85	279.8	54.4
46	45.2	08.8	06	104.1	20.2	66	163.0	31.7	26	221.8	43.1	86	280.7	54.6
47	46.1	09.0	07	105.0	20.4	67	163.9	31.9	27	222.8	43.3	87	281.7	54.8
48	47.1	09.2	08	106.0	20.6	68	164.9	32.1	28	223.8	43.5	88	282.7	55.0
49	48.1	09.3	09	107.0	20.8	69	165.9	32.2	29	224.8	43.7	89	283.7	55.1
50	49.1	09.5	10	108.0	21.0	70	166.9	32.4	30	225.8	43.9	90	284.7	55.3
51	50.1	09.7	111	109.0	21.2	171	167.9	32.6	231	226.8	44.1	291	285.7	55.5
52	51.0	09.9	12	109.9	21.4	72	168.8	32.8	32	227.7	44.3	92	286.6	55.7
53	52.0	10.1	13	110.9	21.6	73	169.8	33.0	33	228.7	44.5	93	287.6	55.9
54	53.0	10.3	14	111.9	21.8	74	170.8	33.2	34	229.7	44.6	94	288.6	56.1
55	54.0	10.5	15	112.9	21.9	75	171.8	33.4	35	230.7	44.8	95	289.6	56.3
56	55.0	10.7	16	113.9	22.1	76	172.8	33.6	36	231.7	45.0	96	290.6	56.5
57	56.0	10.9	17	114.9	22.3	77	173.7	33.8	37	232.6	45.2	97	291.5	56.7
58	56.9	11.1	18	115.8	22.5	78	174.7	34.0	38	233.6	45.4	98	292.5	56.9
59	57.9	11.3	19	116.8	22.7	79	175.7	34.2	39	234.6	45.6	99	293.5	57.1
60	58.9	11.4	20	117.8	22.9	80	176.7	34.3	40	235.6	45.8	300	294.5	57.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 79 Degrees.

TABLE II.

Difference of Latitude and Departure for 12 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.7	12.7	121	118.4	25.2	181	177.0	37.6	241	235.7	50.1
2	02.0	00.4	62	60.6	12.9	22	119.3	25.4	82	178.0	37.8	42	236.7	50.3
3	02.9	00.6	63	61.6	13.1	23	120.3	25.6	83	179.0	38.0	43	237.7	50.5
4	03.9	00.8	64	62.6	13.3	24	121.3	25.8	84	180.0	38.3	44	238.7	50.7
5	04.9	01.0	65	63.6	13.5	25	122.3	26.0	85	181.0	38.5	45	239.6	50.9
6	05.9	01.2	66	64.6	13.7	26	123.2	26.2	86	181.9	38.7	46	240.6	51.1
7	06.8	01.5	67	65.5	13.9	27	124.2	26.4	87	182.9	38.9	47	241.6	51.4
8	07.8	01.7	68	66.5	14.1	28	125.2	26.6	88	183.9	39.1	48	242.6	51.6
9	08.8	01.9	69	67.5	14.3	29	126.2	26.8	89	184.9	39.3	49	243.6	51.8
10	09.8	02.1	70	68.5	14.6	30	127.2	27.0	90	185.8	39.5	50	244.5	52.0
11	10.8	02.3	71	69.4	14.8	131	128.1	27.2	191	186.8	39.7	251	245.5	52.2
12	11.7	02.5	72	70.4	15.0	32	129.1	27.4	92	187.8	39.9	52	246.5	52.4
13	12.7	02.7	73	71.4	15.2	33	130.1	27.7	93	188.8	40.1	53	247.5	52.6
14	13.7	02.9	74	72.4	15.4	34	131.1	27.9	94	189.8	40.3	54	248.4	52.8
15	14.7	03.1	75	73.4	15.6	35	132.0	28.1	95	190.7	40.5	55	249.4	53.0
16	15.7	03.3	76	74.3	15.8	36	133.0	28.3	96	191.7	40.8	56	250.4	53.2
17	16.6	03.5	77	75.3	16.0	37	134.0	28.5	97	192.7	41.0	57	251.4	53.4
18	17.6	03.7	78	76.3	16.2	38	135.0	28.7	98	193.7	41.2	58	252.4	53.6
19	18.6	04.0	79	77.3	16.4	39	136.0	28.9	99	194.7	41.4	59	253.3	53.8
20	19.6	04.2	80	78.3	16.6	40	136.9	29.1	200	195.6	41.6	60	254.3	54.1
21	20.5	04.4	81	79.2	16.8	141	137.9	29.3	201	196.6	41.8	261	255.3	54.3
22	21.5	04.6	82	80.2	17.0	42	138.9	29.5	02	197.6	42.0	62	256.3	54.5
23	22.5	04.8	83	81.2	17.3	43	139.9	29.7	03	198.6	42.2	63	257.3	54.7
24	23.5	05.0	84	82.2	17.5	44	140.9	29.9	04	199.5	42.4	64	258.2	54.9
25	24.5	05.2	85	83.1	17.7	45	141.8	30.1	05	200.5	42.6	65	259.2	55.1
26	25.4	05.4	86	84.1	17.9	46	142.8	30.4	06	201.5	42.8	66	260.2	55.3
27	26.4	05.6	87	85.1	18.1	47	143.8	30.6	07	202.5	43.0	67	261.2	55.5
28	27.4	05.8	88	86.1	18.3	48	144.8	30.8	08	203.5	43.2	68	262.1	55.7
29	28.4	06.0	89	87.1	18.5	49	145.7	31.0	09	204.4	43.5	69	263.1	55.9
30	29.3	06.2	90	88.0	18.7	50	146.7	31.2	10	205.4	43.7	70	264.1	56.1
31	30.3	06.4	91	89.0	18.9	151	147.7	31.4	211	206.4	43.9	271	265.1	56.3
32	31.3	06.7	92	90.0	19.1	52	148.7	31.6	12	207.4	44.1	72	266.1	56.6
33	32.3	06.9	93	91.0	19.3	53	149.7	31.8	13	208.3	44.3	73	267.0	56.8
34	33.3	07.1	94	91.9	19.5	54	150.6	32.0	14	209.3	44.5	74	268.0	57.0
35	34.2	07.3	95	92.9	19.8	55	151.6	32.2	15	210.3	44.7	75	269.0	57.2
36	35.2	07.5	96	93.9	20.0	56	152.6	32.4	16	211.3	44.9	76	270.0	57.4
37	36.2	07.7	97	94.9	20.2	57	153.6	32.6	17	212.3	45.1	77	270.9	57.6
38	37.2	07.9	98	95.9	20.4	58	154.5	32.9	18	213.2	45.3	78	271.9	57.8
39	38.1	08.1	99	96.8	20.6	59	155.5	33.1	19	214.2	45.5	79	272.9	58.0
40	39.1	08.3	100	97.8	20.8	60	156.5	33.3	20	215.2	45.7	80	273.9	58.2
41	40.1	08.5	101	98.8	21.0	161	157.5	33.5	221	216.2	45.9	281	274.9	58.4
42	41.1	08.7	02	99.8	21.2	62	158.5	33.7	22	217.1	46.2	82	275.8	58.6
43	42.1	08.9	03	100.7	21.4	63	159.4	33.9	23	218.1	46.4	83	276.8	58.8
44	43.0	09.1	04	101.7	21.6	64	160.4	34.1	24	219.1	46.6	84	277.8	59.0
45	44.0	09.4	05	102.7	21.8	65	161.4	34.3	25	220.1	46.8	85	278.8	59.3
46	45.0	09.6	06	103.7	22.0	66	162.4	34.5	26	221.1	47.0	86	279.8	59.5
47	46.0	09.8	07	104.7	22.2	67	163.4	34.7	27	222.0	47.2	87	280.7	59.7
48	47.0	10.0	08	105.7	22.5	68	164.3	34.9	28	223.0	47.4	88	281.7	59.9
49	47.9	10.2	09	106.6	22.7	69	165.3	35.1	29	224.0	47.6	89	282.7	60.1
50	48.9	10.4	10	107.6	22.9	70	166.3	35.3	30	225.0	47.8	90	283.7	60.3
51	49.9	10.6	111	108.6	23.1	171	167.3	35.6	231	226.0	48.0	291	284.6	60.5
52	50.9	10.8	12	109.6	23.3	72	168.2	35.8	32	226.9	48.2	92	285.6	60.7
53	51.8	11.0	13	110.5	23.5	73	169.2	36.0	33	227.9	48.4	93	286.6	60.9
54	52.8	11.2	14	111.5	23.7	74	170.2	36.2	34	228.9	48.7	94	287.6	61.1
55	53.8	11.4	15	112.5	23.9	75	171.2	36.4	35	229.9	48.9	95	288.6	61.3
56	54.8	11.6	16	113.5	24.1	76	172.2	36.6	36	230.8	49.1	96	289.5	61.5
57	55.8	11.9	17	114.4	24.3	77	173.1	36.8	37	231.8	49.3	97	290.5	61.7
58	56.7	12.1	18	115.4	24.5	78	174.1	37.0	38	232.8	49.5	98	291.5	62.0
59	57.7	12.3	19	116.4	24.7	79	175.1	37.2	39	233.8	49.7	99	292.5	62.2
60	58.7	12.5	20	117.4	24.9	80	176.1	37.4	40	234.8	49.9	300	293.4	62.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 78 Degrees.

TABLE II.

Difference of Latitude and Departure for 13 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.4	13.7	121	117.9	27.2	181	176.4	40.7	241	234.8	54.2
2	01.9	00.4	62	60.4	13.9	22	118.9	27.4	82	177.3	40.9	42	235.8	54.4
3	02.9	00.7	63	61.4	14.2	23	119.8	27.7	83	178.3	41.2	43	236.8	54.7
4	03.9	00.9	64	62.4	14.4	24	120.8	27.9	84	179.3	41.4	44	237.7	54.9
5	04.9	01.1	65	63.3	14.6	25	121.8	28.1	85	180.3	41.6	45	238.7	55.1
6	05.8	01.3	66	64.3	14.8	26	122.8	28.3	86	181.2	41.8	46	239.7	55.3
7	06.8	01.6	67	65.3	15.1	27	123.7	28.6	87	182.2	42.1	47	240.7	55.6
8	07.8	01.8	68	66.3	15.3	28	124.7	28.8	88	183.2	42.3	48	241.6	55.8
9	08.8	02.0	69	67.2	15.5	29	125.7	29.0	89	184.2	42.5	49	242.6	56.0
10	09.7	02.2	70	68.2	15.7	30	126.7	29.2	90	185.1	42.7	50	243.6	56.2
11	10.7	02.5	71	69.2	16.0	131	127.6	29.5	191	186.1	43.0	251	244.6	56.5
12	11.7	02.7	72	70.2	16.2	32	128.6	29.7	92	187.1	43.2	52	245.5	56.7
13	12.7	02.9	73	71.1	16.4	33	129.6	29.9	93	188.1	43.4	53	246.5	56.9
14	13.6	03.1	74	72.1	16.6	34	130.6	30.1	94	189.0	43.6	54	247.5	57.1
15	14.6	03.4	75	73.1	16.9	35	131.5	30.4	95	190.0	43.9	55	248.5	57.4
16	15.6	03.6	76	74.1	17.1	36	132.5	30.6	96	191.0	44.1	56	249.4	57.6
17	16.6	03.8	77	75.0	17.3	37	133.5	30.8	97	192.0	44.3	57	250.4	57.8
18	17.5	04.0	78	76.0	17.5	38	134.5	31.0	98	192.9	44.5	58	251.4	58.0
19	18.5	04.3	79	77.0	17.8	39	135.4	31.3	99	193.9	44.8	59	252.4	58.3
20	19.5	04.5	80	77.9	18.0	40	136.4	31.5	200	194.9	45.0	60	253.3	58.5
21	20.5	04.7	81	78.9	18.2	141	137.4	31.7	201	195.8	45.2	261	254.3	58.7
22	21.4	04.9	82	79.9	18.4	42	138.4	31.9	02	196.8	45.4	62	255.3	58.9
23	22.4	05.2	83	80.9	18.7	43	139.3	32.2	03	197.8	45.7	63	256.3	59.2
24	23.4	05.4	84	81.8	18.9	44	140.3	32.4	04	198.8	45.9	64	257.2	59.4
25	24.4	05.6	85	82.8	19.1	45	141.3	32.6	05	199.7	46.1	65	258.2	59.6
26	25.3	05.8	86	83.8	19.3	46	142.3	32.8	06	200.7	46.3	66	259.2	59.8
27	26.3	06.1	87	84.8	19.6	47	143.2	33.1	07	201.7	46.6	67	260.2	60.1
28	27.3	06.3	88	85.7	19.8	48	144.2	33.3	08	202.7	46.8	68	261.1	60.3
29	28.3	06.5	89	86.7	20.0	49	145.2	33.5	09	203.6	47.0	69	262.1	60.5
30	29.2	06.7	90	87.7	20.2	50	146.2	33.7	10	204.6	47.2	70	263.1	60.7
31	30.2	07.0	91	88.7	20.5	151	147.1	34.0	211	205.6	47.5	271	264.1	61.0
32	31.2	07.2	92	89.6	20.7	52	148.1	34.2	12	206.6	47.7	72	265.0	61.2
33	32.2	07.4	93	90.6	20.9	53	149.1	34.4	13	207.5	47.9	73	266.0	61.4
34	33.1	07.6	94	91.6	21.1	54	150.1	34.6	14	208.5	48.1	74	267.0	61.6
35	34.1	07.9	95	92.6	21.4	55	151.0	34.9	15	209.5	48.4	75	268.0	61.9
36	35.1	08.1	96	93.5	21.6	56	152.0	35.1	16	210.5	48.6	76	268.9	62.1
37	36.1	08.3	97	94.5	21.8	57	153.0	35.3	17	211.4	48.8	77	269.9	62.3
38	37.0	08.5	98	95.5	22.0	58	154.0	35.5	18	212.4	49.0	78	270.9	62.5
39	38.0	08.8	99	96.5	22.3	59	154.9	35.8	19	213.4	49.3	79	271.8	62.8
40	39.0	09.0	100	97.4	22.5	60	155.9	36.0	20	214.4	49.5	80	272.8	63.0
41	39.9	09.2	101	98.4	22.7	161	156.9	36.2	221	215.3	49.7	281	273.8	63.2
42	40.9	09.4	02	99.4	22.9	62	157.8	36.4	22	216.3	49.9	82	274.8	63.4
43	41.9	09.7	03	100.4	23.2	63	158.8	36.7	23	217.3	50.2	83	275.7	63.7
44	42.9	09.9	04	101.3	23.4	64	159.8	36.9	24	218.3	50.4	84	276.7	63.9
45	43.8	10.1	05	102.3	23.6	65	160.8	37.1	25	219.2	50.6	85	277.7	64.1
46	44.8	10.3	06	103.3	23.8	66	161.7	37.3	26	220.2	50.8	86	278.7	64.3
47	45.8	10.6	07	104.3	24.1	67	162.7	37.6	27	221.2	51.1	87	279.6	64.6
48	46.8	10.8	08	105.2	24.3	68	163.7	37.8	28	222.2	51.3	88	280.6	64.8
49	47.7	11.0	09	106.2	24.5	69	164.7	38.0	29	223.1	51.5	89	281.6	65.0
50	48.7	11.2	10	107.2	24.7	70	165.6	38.2	30	224.1	51.7	90	282.6	65.2
51	49.7	11.5	111	108.2	25.0	171	166.6	38.5	231	225.1	52.0	291	283.5	65.5
52	50.7	11.7	12	109.1	25.2	72	167.6	38.7	32	226.1	52.2	92	284.5	65.7
53	51.6	11.9	13	110.1	25.4	73	168.6	38.9	33	227.0	52.4	93	285.5	65.9
54	52.6	12.1	14	111.1	25.6	74	169.5	39.1	34	228.0	52.6	94	286.5	66.1
55	53.6	12.4	15	112.1	25.9	75	170.5	39.4	35	229.0	52.9	95	287.4	66.4
56	54.6	12.6	16	113.0	26.1	76	171.5	39.6	36	230.0	53.1	96	288.4	66.6
57	55.5	12.8	17	114.0	26.3	77	172.5	39.8	37	230.9	53.3	97	289.4	66.8
58	56.5	13.0	18	115.0	26.5	78	173.4	40.0	38	231.9	53.5	98	290.4	67.0
59	57.5	13.3	19	116.0	26.8	79	174.4	40.3	39	232.9	53.8	99	291.3	67.3
60	58.5	13.5	20	116.9	27.0	80	175.4	40.5	40	233.8	54.0	300	292.3	67.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 77 Degrees.

TABLE II.

Difference of Latitude and Departure for 14 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.2	14.8	121	117.4	29.3	181	175.6	43.8	241	233.8	58.3
2	01.9	00.5	62	60.2	15.0	22	118.4	29.5	82	176.6	44.0	42	234.8	58.5
3	02.9	00.7	63	61.1	15.2	23	119.3	29.8	83	177.6	44.3	43	235.8	58.8
4	03.9	01.0	64	62.1	15.5	24	120.3	30.0	84	178.5	44.5	44	236.8	59.0
5	04.9	01.2	65	63.1	15.7	25	121.3	30.2	85	179.5	44.8	45	237.7	59.3
6	05.8	01.5	66	64.0	16.0	26	122.3	30.5	86	180.5	45.0	46	238.7	59.5
7	06.8	01.7	67	65.0	16.2	27	123.2	30.7	87	181.4	45.2	47	239.7	59.8
8	07.8	01.9	68	66.0	16.5	28	124.2	31.0	88	182.4	45.5	48	240.6	60.0
9	08.7	02.2	69	67.0	16.7	29	125.2	31.2	89	183.4	45.7	49	241.6	60.2
10	09.7	02.4	70	67.9	16.9	30	126.1	31.4	90	184.4	46.0	50	242.6	60.5
11	10.7	02.7	71	68.9	17.2	131	127.1	31.7	191	185.3	46.2	251	243.5	60.7
12	11.6	02.9	72	69.9	17.4	32	128.1	31.9	92	186.3	46.4	52	244.5	61.0
13	12.6	03.1	73	70.8	17.7	33	129.0	32.2	93	187.3	46.7	53	245.5	61.2
14	13.6	03.4	74	71.8	17.9	34	130.0	32.4	94	188.2	46.9	54	246.5	61.4
15	14.6	03.6	75	72.8	18.1	35	131.0	32.7	95	189.2	47.2	55	247.4	61.7
16	15.5	03.9	76	73.7	18.4	36	132.0	32.9	96	190.2	47.4	56	248.4	61.9
17	16.5	04.1	77	74.7	18.6	37	132.9	33.1	97	191.1	47.7	57	249.4	62.2
18	17.5	04.4	78	75.7	18.9	38	133.9	33.4	98	192.1	47.9	58	250.3	62.4
19	18.4	04.6	79	76.7	19.1	39	134.9	33.6	99	193.1	48.1	59	251.3	62.7
20	19.4	04.8	80	77.6	19.4	40	135.8	33.9	200	194.1	48.4	60	252.3	62.9
21	20.4	05.1	81	78.6	19.6	141	136.8	34.1	201	195.0	48.6	261	253.2	63.1
22	21.3	05.3	82	79.6	19.8	42	137.8	34.4	02	196.0	48.9	62	254.2	63.4
23	22.3	05.6	83	80.5	20.1	43	138.8	34.6	03	197.0	49.1	63	255.2	63.6
24	23.3	05.8	84	81.5	20.3	44	139.7	34.8	04	197.9	49.4	64	256.2	63.9
25	24.3	06.0	85	82.5	20.6	45	140.7	35.1	05	198.9	49.6	65	257.1	64.1
26	25.2	06.3	86	83.4	20.8	46	141.7	35.3	06	199.9	49.8	66	258.1	64.4
27	26.2	06.5	87	84.4	21.0	47	142.6	35.6	07	200.9	50.1	67	259.1	64.6
28	27.2	06.8	88	85.4	21.3	48	143.6	35.8	08	201.8	50.3	68	260.0	64.8
29	28.1	07.0	89	86.4	21.5	49	144.6	36.0	09	202.8	50.6	69	261.0	65.1
30	29.1	07.3	90	87.3	21.8	50	145.5	36.3	10	203.8	50.8	70	262.0	65.3
31	30.1	07.5	91	88.3	22.0	151	146.5	36.5	211	204.7	51.0	271	263.0	65.6
32	31.0	07.7	92	89.3	22.3	52	147.5	36.8	12	205.7	51.3	72	263.9	65.8
33	32.0	08.0	93	90.2	22.5	53	148.5	37.0	13	206.7	51.5	73	264.9	66.0
34	33.0	08.2	94	91.2	22.7	54	149.4	37.3	14	207.6	51.8	74	265.9	66.3
35	34.0	08.5	95	92.2	23.0	55	150.4	37.5	15	208.6	52.0	75	266.8	66.5
36	34.9	08.7	96	93.1	23.2	56	151.4	37.7	16	209.6	52.3	76	267.8	66.8
37	35.9	09.0	97	94.1	23.5	57	152.3	38.0	17	210.6	52.5	77	268.8	67.0
38	36.9	09.2	98	95.1	23.7	58	153.3	38.2	18	211.5	52.7	78	269.7	67.3
39	37.8	09.4	99	96.1	24.0	59	154.3	38.5	19	212.5	53.0	79	270.7	67.5
40	38.8	09.7	100	97.0	24.2	60	155.2	38.7	20	213.5	53.2	80	271.7	67.7
41	39.8	09.9	101	98.0	24.4	161	156.2	38.9	221	214.4	53.5	281	272.7	68.0
42	40.8	10.2	02	99.0	24.7	62	157.2	39.2	22	215.4	53.7	82	273.6	68.2
43	41.7	10.4	03	99.9	24.9	63	158.2	39.4	23	216.4	53.9	83	274.6	68.5
44	42.7	10.6	04	100.9	25.2	64	159.1	39.7	24	217.3	54.2	84	275.6	68.7
45	43.7	10.9	05	101.9	25.4	65	160.1	39.9	25	218.3	54.4	85	276.5	68.9
46	44.6	11.1	06	102.9	25.6	66	161.1	40.2	26	219.3	54.7	86	277.5	69.2
47	45.6	11.4	07	103.8	25.9	67	162.0	40.4	27	220.3	54.9	87	278.5	69.4
48	46.6	11.6	08	104.8	26.1	68	163.0	40.6	28	221.2	55.2	88	279.4	69.7
49	47.5	11.9	09	105.8	26.4	69	164.0	40.9	29	222.2	55.4	89	280.4	69.9
50	48.5	12.1	10	106.7	26.6	70	165.0	41.1	30	223.2	55.6	90	281.4	70.2
51	49.5	12.3	111	107.7	26.9	171	165.9	41.4	231	224.1	55.9	291	282.4	70.4
52	50.5	12.6	12	108.7	27.1	72	166.9	41.6	32	225.1	56.1	92	283.3	70.6
53	51.4	12.8	13	109.6	27.3	73	167.9	41.9	33	226.1	56.4	93	284.3	70.9
54	52.4	13.1	14	110.6	27.6	74	168.8	42.1	34	227.0	56.6	94	285.3	71.1
55	53.4	13.3	15	111.6	27.8	75	169.8	42.3	35	228.0	56.9	95	286.2	71.4
56	54.3	13.5	16	112.6	28.1	76	170.8	42.6	36	229.0	57.1	96	287.2	71.6
57	55.3	13.8	17	113.5	28.3	77	171.7	42.8	37	230.0	57.3	97	288.2	71.9
58	56.3	14.0	18	114.5	28.5	78	172.7	43.1	38	230.9	57.6	98	289.1	72.1
59	57.2	14.3	19	115.5	28.8	79	173.7	43.3	39	231.9	57.8	99	290.1	72.3
60	58.2	14.5	20	116.4	29.0	80	174.7	43.5	40	232.9	58.1	300	291.1	72.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 76 Degrees.

TABLE II.

Difference of Latitude and Departure for 15 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.9	15.8	121	116.9	31.3	181	174.8	46.8	241	232.8	62.4
2	01.9	00.5	62	59.9	16.0	22	117.8	31.6	82	175.8	47.1	42	233.8	62.6
3	02.9	00.8	63	60.9	16.3	23	118.8	31.8	83	176.8	47.4	43	234.7	62.9
4	03.9	01.0	64	61.8	16.6	24	119.8	32.1	84	177.7	47.6	44	235.7	63.2
5	04.8	01.3	65	62.8	16.8	25	120.7	32.4	85	178.7	47.9	45	236.7	63.4
6	05.8	01.6	66	63.8	17.1	26	121.7	32.6	86	179.7	48.1	46	237.6	63.7
7	06.8	01.8	67	64.7	17.3	27	122.7	32.9	87	180.6	48.4	47	238.6	63.9
8	07.7	02.1	68	65.7	17.6	28	123.6	33.1	88	181.6	48.7	48	239.5	64.2
9	08.7	02.3	69	66.6	17.9	29	124.6	33.4	89	182.6	48.9	49	240.5	64.4
10	09.7	02.6	70	67.6	18.1	30	125.6	33.6	90	183.5	49.2	50	241.5	64.7
11	10.6	02.8	71	68.6	18.4	131	126.5	33.9	191	184.5	40.4	251	242.4	65.0
12	11.6	03.1	72	69.5	18.6	32	127.5	34.2	92	185.5	49.7	52	243.4	65.2
13	12.6	03.4	73	70.5	18.9	33	128.5	34.4	93	186.4	50.0	53	244.4	65.5
14	13.5	03.6	74	71.5	19.2	34	129.4	34.7	94	187.4	50.2	54	245.3	65.7
15	14.5	03.9	75	72.4	19.4	35	130.4	34.9	95	188.4	50.5	55	246.3	66.0
16	15.5	04.1	76	73.4	19.7	36	131.4	35.2	96	189.3	50.7	56	247.3	66.3
17	16.4	04.4	77	74.4	19.9	37	132.3	35.5	97	190.3	51.0	57	248.2	66.5
18	17.4	04.7	78	75.3	20.2	38	133.3	35.7	98	191.3	51.2	58	249.2	66.8
19	18.4	04.9	79	76.3	20.4	39	134.3	36.0	99	192.2	51.5	59	250.2	67.0
20	19.3	05.2	80	77.3	20.7	40	135.2	36.2	200	193.2	51.8	60	251.1	67.3
21	20.3	05.4	81	78.2	21.0	141	136.2	36.5	201	194.2	52.0	261	252.1	67.6
22	21.3	05.7	82	79.2	21.2	42	137.2	36.8	02	195.1	52.3	62	253.1	67.8
23	22.2	06.0	83	80.2	21.5	43	138.1	37.0	03	196.1	52.5	63	254.0	68.1
24	23.2	06.2	84	81.1	21.7	44	139.1	37.3	04	197.0	52.8	64	255.0	68.3
25	24.1	06.5	85	82.1	22.0	45	140.1	37.5	05	198.0	53.1	65	256.0	68.6
26	25.1	06.7	86	83.1	22.3	46	141.0	37.8	06	199.0	53.3	66	256.9	68.8
27	26.1	07.0	87	84.0	22.5	47	142.0	38.0	07	199.9	53.6	67	257.9	69.1
28	27.0	07.2	88	85.0	22.8	48	143.0	38.3	08	200.9	53.8	68	258.9	69.4
29	28.0	07.5	89	86.0	23.0	49	143.9	38.6	09	201.9	54.1	69	259.8	69.6
30	29.0	07.8	90	86.9	23.3	50	144.9	38.8	10	202.8	54.4	70	260.8	69.9
31	29.9	08.0	91	87.9	23.6	151	145.9	39.1	211	203.8	54.6	271	261.8	70.1
32	30.9	08.3	92	88.9	23.8	52	146.8	39.3	12	204.8	54.9	72	262.7	70.4
33	31.9	08.5	93	89.8	24.1	53	147.8	39.6	13	205.7	55.1	73	263.7	70.7
34	32.8	08.8	94	90.8	24.3	54	148.8	39.9	14	206.7	55.4	74	264.7	70.9
35	33.8	09.1	95	91.8	24.6	55	149.7	40.1	15	207.7	55.6	75	265.6	71.2
36	34.8	09.3	96	92.7	24.8	56	150.7	40.4	16	208.6	55.9	76	266.6	71.4
37	35.7	09.6	97	93.7	25.1	57	151.7	40.6	17	209.6	56.2	77	267.6	71.7
38	36.7	09.8	98	94.7	25.4	58	152.6	40.9	18	210.6	56.4	78	268.5	72.0
39	37.7	10.1	99	95.6	25.6	59	153.6	41.2	19	211.5	56.7	79	269.5	72.2
40	38.6	10.4	100	96.6	25.9	60	154.5	41.4	20	212.5	56.9	80	270.5	72.5
41	39.6	10.6	101	97.6	26.1	161	155.5	41.7	221	213.5	57.2	281	271.4	72.7
42	40.6	10.9	02	98.5	26.4	62	156.5	41.9	22	214.4	57.5	82	272.4	73.0
43	41.5	11.1	03	99.5	26.7	63	157.4	42.2	23	215.4	57.7	83	273.4	73.2
44	42.5	11.4	04	100.5	26.9	64	158.4	42.4	24	216.4	58.0	84	274.3	73.5
45	43.5	11.6	05	101.4	27.2	65	159.4	42.7	25	217.3	58.2	85	275.3	73.8
46	44.4	11.9	06	102.4	27.4	66	160.3	43.0	26	218.3	58.5	86	276.3	74.0
47	45.4	12.2	07	103.4	27.7	67	161.3	43.2	27	219.3	58.8	87	277.2	74.3
48	46.4	12.4	08	104.3	28.0	68	162.3	43.5	28	220.2	59.0	88	278.2	74.5
49	47.3	12.7	09	105.3	28.2	69	163.2	43.7	29	221.2	59.3	89	279.2	74.8
50	48.3	12.9	10	106.3	28.5	70	164.2	44.0	30	222.2	59.5	90	280.1	75.1
51	49.3	13.2	111	107.2	28.7	171	165.2	44.3	231	223.1	59.8	291	281.1	75.3
52	50.2	13.5	12	108.2	29.0	72	166.1	44.5	32	224.1	60.0	92	282.1	75.6
53	51.2	13.7	13	109.1	29.2	73	167.1	44.8	33	225.1	60.3	93	283.0	75.8
54	52.2	14.0	14	110.1	29.5	74	168.1	45.0	34	226.0	60.6	94	284.0	76.1
55	53.1	14.2	15	111.1	29.8	75	169.0	45.3	35	227.0	60.8	95	284.9	76.4
56	54.1	14.5	16	112.0	30.0	76	170.0	45.6	36	228.0	61.1	96	285.9	76.6
57	55.1	14.8	17	113.0	30.3	77	171.0	45.8	37	228.9	61.3	97	286.9	76.9
58	56.0	15.0	18	114.0	30.5	78	171.9	46.1	38	229.9	61.6	98	287.8	77.1
59	57.0	15.3	19	114.9	30.8	79	172.9	46.3	39	230.9	61.9	99	288.8	77.4
60	58.0	15.5	20	115.9	31.1	80	173.9	46.6	40	231.8	62.1	300	289.8	77.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 75 Degrees.

TABLE II.

Difference of Latitude and Departure for 16 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.6	16.8	121	116.3	33.4	181	174.0	49.9	241	231.7	66.4
2	01.9	00.6	62	59.6	17.1	22	117.3	33.6	82	174.9	50.2	42	232.6	66.7
3	02.9	00.8	63	60.6	17.4	23	118.2	33.9	83	175.9	50.4	43	233.6	67.0
4	03.8	01.1	64	61.5	17.6	24	119.2	34.2	84	176.9	50.7	44	234.5	67.3
5	04.8	01.4	65	62.5	17.9	25	120.2	34.5	85	177.8	51.0	45	235.5	67.5
6	05.8	01.7	66	63.4	18.2	26	121.1	34.7	86	178.8	51.3	46	236.5	67.8
7	06.7	01.9	67	64.4	18.5	27	122.1	35.0	87	179.8	51.5	47	237.4	68.1
8	07.7	02.2	68	65.4	18.7	28	123.0	35.3	88	180.7	51.8	48	238.4	68.4
9	08.7	02.5	69	66.3	19.0	29	124.0	35.6	89	181.7	52.1	49	239.4	68.6
10	09.6	02.8	70	67.3	19.3	30	125.0	35.8	90	182.6	52.4	50	240.3	68.9
11	10.6	03.0	71	68.2	19.6	131	125.9	36.1	191	183.6	52.6	251	241.3	69.2
12	11.5	03.3	72	69.2	19.8	32	126.9	36.4	92	184.6	52.9	52	242.2	69.5
13	12.5	03.6	73	70.2	20.1	33	127.8	36.7	93	185.5	53.2	53	243.2	69.7
14	13.5	03.9	74	71.1	20.4	34	128.8	36.9	94	186.5	53.5	54	244.2	70.0
15	14.4	04.1	75	72.1	20.7	35	129.8	37.2	95	187.4	53.7	55	245.1	70.3
16	15.4	04.4	76	73.1	20.9	36	130.7	37.5	96	188.4	54.0	56	246.1	70.6
17	16.3	04.7	77	74.0	21.2	37	131.7	37.8	97	189.4	54.3	57	247.0	70.8
18	17.3	05.0	78	75.0	21.5	38	132.7	38.0	98	190.3	54.6	58	248.0	71.1
19	18.3	05.2	79	75.9	21.8	39	133.6	38.3	99	191.3	54.9	59	249.0	71.4
20	19.2	05.5	80	76.9	22.1	40	134.6	38.6	200	192.3	55.1	60	249.9	71.7
21	20.2	05.8	81	77.9	22.3	141	135.5	38.9	201	193.2	55.4	261	250.9	71.9
22	21.1	06.1	82	78.8	22.6	42	136.5	39.1	02	194.2	55.7	62	251.9	72.2
23	22.1	06.3	83	79.8	22.9	43	137.5	39.4	03	195.1	56.0	63	252.8	72.5
24	23.1	06.6	84	80.7	23.2	44	138.4	39.7	04	196.1	56.2	64	253.8	72.8
25	24.0	06.9	85	81.7	23.4	45	139.4	40.0	05	197.1	56.5	65	254.7	73.0
26	25.0	07.2	86	82.7	23.7	46	140.3	40.2	06	198.0	56.8	66	255.7	73.3
27	26.0	07.4	87	83.6	24.0	47	141.3	40.5	07	199.0	57.1	67	256.7	73.6
28	26.9	07.7	88	84.6	24.3	48	142.3	40.8	08	199.9	57.3	68	257.6	73.9
29	27.9	08.0	89	85.6	24.5	49	143.2	41.1	09	200.9	57.6	69	258.6	74.1
30	28.8	08.3	90	86.5	24.8	50	144.2	41.3	10	201.9	57.9	70	259.5	74.4
31	29.8	08.5	91	87.5	25.1	151	145.2	41.6	211	202.8	58.2	271	260.5	74.7
32	30.8	08.8	92	88.4	25.4	52	146.1	41.9	12	203.8	58.4	72	261.5	75.0
33	31.7	09.1	93	89.4	25.6	53	147.1	42.2	13	204.7	58.7	73	262.4	75.2
34	32.7	09.4	94	90.4	25.9	54	148.0	42.4	14	205.7	59.0	74	263.4	75.5
35	33.6	09.6	95	91.3	26.2	55	149.0	42.7	15	206.7	59.3	75	264.3	75.8
36	34.6	09.9	96	92.3	26.5	56	150.0	43.0	16	207.6	59.5	76	265.3	76.1
37	35.6	10.2	97	93.2	26.7	57	150.9	43.3	17	208.6	59.8	77	266.3	76.4
38	36.5	10.5	98	94.2	27.0	58	151.9	43.6	18	209.6	60.1	78	267.2	76.6
39	37.5	10.7	99	95.2	27.3	59	152.8	43.8	19	210.5	60.4	79	268.2	76.9
40	38.5	11.0	100	96.1	27.6	60	153.8	44.1	20	211.5	60.6	80	269.2	77.2
41	39.4	11.3	101	97.1	27.8	161	154.8	44.4	221	212.4	60.9	281	270.1	77.5
42	40.4	11.6	02	98.0	28.1	62	155.7	44.7	22	213.4	61.2	82	271.1	77.7
43	41.3	11.9	03	99.0	28.4	63	156.7	44.9	23	214.4	61.5	83	272.0	78.0
44	42.3	12.1	04	100.0	28.7	64	157.6	45.2	24	215.3	61.7	84	273.0	78.3
45	43.3	12.4	05	100.9	28.9	65	158.6	45.5	25	216.3	62.0	85	274.0	78.6
46	44.2	12.7	06	101.9	29.2	66	159.6	45.8	26	217.2	62.3	86	274.9	78.8
47	45.2	13.0	07	102.9	29.5	67	160.5	46.0	27	218.2	62.6	87	275.9	79.1
48	46.1	13.2	08	103.8	29.8	68	161.5	46.3	28	219.2	62.8	88	276.8	79.4
49	47.1	13.5	09	104.8	30.0	69	162.5	46.6	29	220.1	63.1	89	277.8	79.7
50	48.1	13.8	10	105.7	30.3	70	163.4	46.9	30	221.1	63.4	90	278.8	79.9
51	49.0	14.1	111	106.7	30.6	171	164.4	47.1	231	222.1	63.7	291	279.7	80.2
52	50.0	14.3	12	107.7	30.9	72	165.3	47.4	32	223.0	63.9	92	280.7	80.5
53	50.9	14.6	13	108.6	31.1	73	166.3	47.7	33	224.0	64.2	93	281.6	80.8
54	51.9	14.9	14	109.6	31.4	74	167.3	48.0	34	224.9	64.5	94	282.6	81.0
55	52.9	15.2	15	110.5	31.7	75	168.2	48.2	35	225.9	64.8	95	283.6	81.3
56	53.8	15.4	16	111.5	32.0	76	169.2	48.5	36	226.9	65.1	96	284.5	81.6
57	54.8	15.7	17	112.5	32.2	77	170.1	48.8	37	227.8	65.3	97	285.5	81.9
58	55.8	16.0	18	113.4	32.5	78	171.1	49.1	38	228.8	65.6	98	286.5	82.1
59	56.7	16.3	19	114.4	32.8	79	172.1	49.3	39	229.7	65.9	99	287.4	82.4
60	57.7	16.5	20	115.4	33.1	80	173.0	49.6	40	230.7	66.2	300	288.4	82.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 74 Degrees.

Difference of Latitude and Departure for 17 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.3	17.8	121	115.7	35.4	181	173.1	52.9	241	230.5	70.5
2	01.9	00.6	62	59.3	18.1	22	116.7	35.7	82	174.0	53.2	42	231.4	70.8
3	02.9	00.9	63	60.2	18.4	23	117.6	36.0	83	175.0	53.5	43	232.4	71.0
4	03.8	01.2	64	61.2	18.7	24	118.6	36.3	84	176.0	53.8	44	233.3	71.3
5	04.8	01.5	65	62.2	19.0	25	119.5	36.5	85	176.9	54.1	45	234.3	71.6
6	05.7	01.8	66	63.1	19.3	26	120.5	36.8	86	177.9	54.4	46	235.3	71.9
7	06.7	02.0	67	64.1	19.6	27	121.5	37.1	87	178.8	54.7	47	236.2	72.2
8	07.7	02.3	68	65.0	19.9	28	122.4	37.4	88	179.8	55.0	48	237.2	72.5
9	08.6	02.6	69	66.0	20.2	29	123.4	37.7	89	180.7	55.3	49	238.1	72.8
10	09.6	02.9	70	66.9	20.5	30	124.3	38.0	90	181.7	55.6	50	239.1	73.1
11	10.5	03.2	71	67.9	20.8	131	125.3	38.3	191	182.7	55.8	251	240.0	73.4
12	11.5	03.5	72	68.9	21.1	32	126.2	38.6	92	183.6	56.1	52	241.0	73.7
13	12.4	03.8	73	69.8	21.3	33	127.2	38.9	93	184.6	56.4	53	241.9	74.0
14	13.4	04.1	74	70.8	21.6	34	128.1	39.2	94	185.5	56.7	54	242.9	74.3
15	14.3	04.4	75	71.7	21.9	35	129.1	39.5	95	186.5	57.0	55	243.9	74.6
16	15.3	04.7	76	72.7	22.2	36	130.1	39.8	96	187.4	57.3	56	244.8	74.8
17	16.3	05.0	77	73.6	22.5	37	131.0	40.1	97	188.4	57.6	57	245.8	75.1
18	17.2	05.3	78	74.6	22.8	38	132.0	40.3	98	189.3	57.9	58	246.7	75.4
19	18.2	05.6	79	75.5	23.1	39	132.9	40.6	99	190.3	58.2	59	247.7	75.7
20	19.1	05.8	80	76.5	23.4	40	133.9	40.9	200	191.3	58.5	60	248.6	76.0
21	20.1	06.1	81	77.5	23.7	141	134.8	41.2	201	192.2	58.8	261	249.6	76.3
22	21.0	06.4	82	78.4	24.0	42	135.8	41.5	02	193.2	59.1	62	250.6	76.6
23	22.0	06.7	83	79.4	24.3	43	136.8	41.8	03	194.1	59.4	63	251.5	76.9
24	23.0	07.0	84	80.3	24.6	44	137.7	42.1	04	195.1	59.6	64	252.5	77.2
25	23.9	07.3	85	81.3	24.9	45	138.7	42.4	05	196.0	59.9	65	253.4	77.5
26	24.9	07.6	86	82.2	25.1	46	139.6	42.7	06	197.0	60.2	66	254.4	77.8
27	25.8	07.9	87	83.2	25.4	47	140.6	43.0	07	198.0	60.5	67	255.3	78.1
28	26.8	08.2	88	84.2	25.7	48	141.5	43.3	08	198.9	60.8	68	256.3	78.4
29	27.7	08.5	89	85.1	26.0	49	142.5	43.6	09	199.9	61.1	69	257.2	78.6
30	28.7	08.8	90	86.1	26.3	50	143.4	43.9	10	200.8	61.4	70	258.2	78.9
31	29.6	09.1	91	87.0	26.6	151	144.4	44.1	211	201.8	61.7	271	259.2	79.2
32	30.6	09.4	92	88.0	26.9	52	145.4	44.4	12	202.7	62.0	72	260.1	79.5
33	31.6	09.6	93	88.9	27.2	53	146.3	44.7	13	203.7	62.3	73	261.1	79.8
34	32.5	09.9	94	89.9	27.5	54	147.3	45.0	14	204.6	62.6	74	262.0	80.1
35	33.5	10.2	95	90.8	27.8	55	148.2	45.3	15	205.6	62.9	75	263.0	80.4
36	34.4	10.5	96	91.8	28.1	56	149.2	45.6	16	206.6	63.2	76	263.9	80.7
37	35.4	10.8	97	92.8	28.4	57	150.1	45.9	17	207.5	63.4	77	264.9	81.0
38	36.3	11.1	98	93.7	28.7	58	151.1	46.2	18	208.5	63.7	78	265.9	81.3
39	37.3	11.4	99	94.7	28.9	59	152.1	46.5	19	209.4	64.0	79	266.8	81.6
40	38.3	11.7	100	95.6	29.2	60	153.0	46.8	20	210.4	64.3	80	267.8	81.9
41	39.2	12.0	101	96.6	29.5	161	154.0	47.1	221	211.3	64.6	281	268.7	82.2
42	40.2	12.3	02	97.5	29.8	62	154.9	47.4	22	212.3	64.9	82	269.7	82.4
43	41.1	12.6	03	98.5	30.1	63	155.9	47.7	23	213.3	65.2	83	270.6	82.7
44	42.1	12.9	04	99.5	30.4	64	156.8	47.9	24	214.2	65.5	84	271.6	83.0
45	43.0	13.2	05	100.4	30.7	65	157.8	48.2	25	215.2	65.8	85	272.5	83.3
46	44.0	13.4	06	101.4	31.0	66	158.7	48.5	26	216.1	66.1	86	273.5	83.6
47	44.9	13.7	07	102.3	31.3	67	159.7	48.8	27	217.1	66.4	87	274.5	83.9
48	45.9	14.0	08	103.3	31.6	68	160.7	49.1	28	218.0	66.7	88	275.4	84.2
49	46.9	14.3	09	104.2	31.9	69	161.6	49.4	29	219.0	67.0	89	276.4	84.5
50	47.8	14.6	10	105.2	32.2	70	162.6	49.7	30	220.0	67.2	90	277.3	84.8
51	48.8	14.9	111	106.1	32.5	171	163.5	50.0	231	220.9	67.5	291	278.3	85.1
52	49.7	15.2	12	107.1	32.7	72	164.5	50.3	32	221.9	67.8	92	279.2	85.4
53	50.7	15.5	13	108.1	33.0	73	165.4	50.6	33	222.8	68.1	93	280.2	85.7
54	51.6	15.8	14	109.0	33.3	74	166.4	50.9	34	223.8	68.4	94	281.2	86.0
55	52.6	16.1	15	110.0	33.6	75	167.4	51.2	35	224.7	68.7	95	282.1	86.2
56	53.6	16.4	16	110.9	33.9	76	168.3	51.5	36	225.7	69.0	96	283.1	86.5
57	54.5	16.7	17	111.9	34.2	77	169.3	51.7	37	226.6	69.3	97	284.0	86.8
58	55.5	17.0	18	112.8	34.5	78	170.2	52.0	38	227.6	69.6	98	285.0	87.1
59	56.4	17.2	19	113.8	34.8	79	171.2	52.3	39	228.6	69.9	99	285.9	87.4
60	57.4	17.5	20	114.8	35.1	80	172.1	52.6	40	229.5	70.2	300	286.9	87.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 73 Degrees.

TABLE II.

Difference of Latitude and Departure for 18 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.0	18.9	121	115.1	37.4	181	172.1	55.9	241	229.2	74.5
2	01.9	00.6	62	59.0	19.2	22	116.0	37.7	82	173.1	56.2	42	230.2	74.8
3	02.9	00.9	63	59.9	19.5	23	117.0	38.0	83	174.0	56.6	43	231.1	75.1
4	03.8	01.2	64	60.9	19.8	24	117.9	38.3	84	175.0	56.9	44	232.1	75.4
5	04.8	01.5	65	61.8	20.1	25	118.9	38.6	85	175.9	57.2	45	233.0	75.7
6	05.7	01.9	66	62.8	20.4	26	119.8	38.9	86	176.9	57.5	46	234.0	76.0
7	06.7	02.2	67	63.7	20.7	27	120.8	39.2	87	177.8	57.8	47	234.9	76.3
8	07.6	02.5	68	64.7	21.0	28	121.7	39.6	88	178.8	58.1	48	235.9	76.6
9	08.6	02.8	69	65.6	21.3	29	122.7	39.9	89	179.7	58.4	49	236.8	76.9
10	09.5	03.1	70	66.6	21.6	30	123.6	40.2	90	180.7	58.7	50	237.8	77.3
11	10.5	03.4	71	67.5	21.9	131	124.6	40.5	191	181.7	59.0	251	238.7	77.6
12	11.4	03.7	72	68.5	22.2	32	125.5	40.8	92	182.6	59.3	52	239.7	77.9
13	12.4	04.0	73	69.4	22.6	33	126.5	41.1	93	183.6	59.6	53	240.6	78.2
14	13.3	04.3	74	70.4	22.9	34	127.4	41.4	94	184.5	59.9	54	241.6	78.5
15	14.3	04.6	75	71.3	23.2	35	128.4	41.7	95	185.5	60.3	55	242.5	78.8
16	15.2	04.9	76	72.3	23.5	36	129.3	42.0	96	186.4	60.6	56	243.5	79.1
17	16.2	05.3	77	73.2	23.8	37	130.3	42.3	97	187.4	60.9	57	244.4	79.4
18	17.1	05.6	78	74.2	24.1	38	131.2	42.6	98	188.3	61.2	58	245.4	79.7
19	18.1	05.9	79	75.1	24.4	39	132.2	43.0	99	189.3	61.5	59	246.3	80.0
20	19.0	06.2	80	76.1	24.7	40	133.1	43.3	200	190.2	61.8	60	247.3	80.3
21	20.0	06.5	81	77.0	25.0	141	134.1	43.6	201	191.2	62.1	261	248.2	80.7
22	20.9	06.8	82	78.0	25.3	42	135.1	43.9	02	192.1	62.4	62	249.2	81.0
23	21.9	07.1	83	78.9	25.6	43	136.0	44.2	03	193.1	62.7	63	250.1	81.3
24	22.8	07.4	84	79.9	26.0	44	137.0	44.5	04	194.0	63.0	64	251.1	81.6
25	23.8	07.7	85	80.8	26.3	45	137.9	44.8	05	195.0	63.3	65	252.0	81.9
26	24.7	08.0	86	81.8	26.6	46	138.9	45.1	06	195.9	63.7	66	253.0	82.2
27	25.7	08.3	87	82.7	26.9	47	139.8	45.4	07	196.9	64.0	67	253.9	82.5
28	26.6	08.7	88	83.7	27.2	48	140.8	45.7	08	197.8	64.3	68	254.9	82.8
29	27.6	09.0	89	84.6	27.5	49	141.7	46.0	09	198.8	64.6	69	255.8	83.1
30	28.5	09.3	90	85.6	27.8	50	142.7	46.4	10	199.7	64.9	70	256.8	83.4
31	29.5	09.6	91	86.5	28.1	151	143.6	46.7	211	200.7	65.2	271	257.7	83.7
32	30.4	09.9	92	87.5	28.4	52	144.6	47.0	12	201.6	65.5	72	258.7	84.1
33	31.4	10.2	93	88.4	28.7	53	145.5	47.3	13	202.6	65.8	73	259.6	84.4
34	32.3	10.5	94	89.4	29.0	54	146.5	47.6	14	203.5	66.1	74	260.6	84.7
35	33.3	10.8	95	90.4	29.4	55	147.4	47.9	15	204.5	66.4	75	261.5	85.0
36	34.2	11.1	96	91.3	29.7	56	148.4	48.2	16	205.4	66.7	76	262.5	85.3
37	35.2	11.4	97	92.3	30.0	57	149.3	48.5	17	206.4	67.1	77	263.4	85.6
38	36.1	11.7	98	93.2	30.3	58	150.3	48.9	18	207.3	67.4	78	264.4	85.9
39	37.1	12.1	99	94.2	30.6	59	151.2	49.1	19	208.3	67.7	79	265.3	86.2
40	38.0	12.4	100	95.1	30.9	60	152.2	49.4	20	209.2	68.0	80	266.3	86.5
41	39.0	12.7	101	96.1	31.2	161	153.1	49.8	221	210.2	68.3	281	267.2	86.8
42	39.9	13.0	02	97.0	31.5	62	154.1	50.1	22	211.1	68.6	82	268.2	87.1
43	40.9	13.3	03	98.0	31.8	63	155.0	50.4	23	212.1	68.9	83	269.1	87.5
44	41.8	13.6	04	98.9	32.1	64	156.0	50.7	24	213.0	69.2	84	270.1	87.8
45	42.8	13.9	05	99.9	32.4	65	156.9	51.0	25	214.0	69.5	85	271.1	88.1
46	43.7	14.2	06	100.8	32.8	66	157.9	51.3	26	214.9	69.8	86	272.0	88.4
47	44.7	14.5	07	101.8	33.1	67	158.8	51.6	27	215.9	70.1	87	273.0	88.7
48	45.7	14.8	08	102.7	33.4	68	159.8	51.9	28	216.8	70.5	88	273.9	89.0
49	46.6	15.1	09	103.7	33.7	69	160.7	52.2	29	217.8	70.8	89	274.9	89.3
50	47.6	15.5	10	104.6	34.0	70	161.7	52.5	30	218.7	71.1	90	275.8	89.6
51	48.5	15.8	111	105.6	34.3	171	162.6	52.8	231	219.7	71.4	291	276.8	89.9
52	49.5	16.1	12	106.5	34.6	72	163.6	53.2	32	220.6	71.7	92	277.7	90.2
53	50.4	16.4	13	107.5	34.9	73	164.5	53.5	33	221.6	72.0	93	278.7	90.5
54	51.4	16.7	14	108.4	35.2	74	165.5	53.8	34	222.5	72.3	94	279.6	90.9
55	52.3	17.0	15	109.4	35.5	75	166.4	54.1	35	223.5	72.6	95	280.6	91.2
56	53.3	17.3	16	110.3	35.8	76	167.4	54.4	36	224.4	72.9	96	281.5	91.5
57	54.2	17.6	17	111.3	36.2	77	168.3	54.7	37	225.4	73.2	97	282.5	91.8
58	55.2	17.9	18	112.2	36.5	78	169.3	55.0	38	226.4	73.5	98	283.4	92.1
59	56.1	18.2	19	113.2	36.8	79	170.2	55.3	39	227.3	73.9	99	284.4	92.4
60	57.1	18.5	20	114.1	37.1	80	171.2	55.6	40	228.3	74.2	300	285.3	92.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 72 Degrees.

TABLE II.

Difference of Latitude and Departure for 19 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.7	19.9	121	114.4	39.4	181	171.1	58.9	241	227.9	78.5
2	01.9	00.7	62	58.6	20.2	22	115.4	39.7	82	172.1	59.3	42	228.8	78.8
3	02.8	01.0	63	59.6	20.5	23	116.3	40.0	83	173.0	59.6	43	229.8	79.1
4	03.8	01.3	64	60.5	20.8	24	117.2	40.4	84	174.0	59.9	44	230.7	79.4
5	04.7	01.6	65	61.5	21.2	25	118.2	40.7	85	174.9	60.2	45	231.7	79.8
6	05.7	02.0	66	62.4	21.5	26	119.1	41.0	86	175.9	60.6	46	232.6	80.1
7	06.6	02.3	67	63.3	21.8	27	120.1	41.3	87	176.8	60.9	47	233.5	80.4
8	07.6	02.6	68	64.3	22.1	28	121.0	41.7	88	177.8	61.2	48	234.5	80.7
9	08.5	02.9	69	65.2	22.5	29	122.0	42.0	89	178.7	61.5	49	235.4	81.1
10	09.5	03.3	70	66.2	22.8	30	122.9	42.3	90	179.6	61.9	50	236.4	81.4
11	10.4	03.6	71	67.1	23.1	131	123.9	42.6	191	180.6	62.2	251	237.3	81.7
12	11.3	03.9	72	68.1	23.4	32	124.8	43.0	92	181.5	62.5	52	238.3	82.0
13	12.3	04.2	73	69.0	23.8	33	125.8	43.3	93	182.5	62.8	53	239.2	82.4
14	13.2	04.6	74	70.0	24.1	34	126.7	43.6	94	183.4	63.2	54	240.2	82.7
15	14.2	04.9	75	70.9	24.4	35	127.6	44.0	95	184.4	63.5	55	241.1	83.0
16	15.1	05.2	76	71.9	24.7	36	128.6	44.3	96	185.3	63.8	56	242.1	83.3
17	16.1	05.5	77	72.8	25.1	37	129.5	44.6	97	186.3	64.1	57	243.0	83.7
18	17.0	05.9	78	73.8	25.4	38	130.5	44.9	98	187.2	64.5	58	243.9	84.0
19	18.0	06.2	79	74.7	25.7	39	131.4	45.3	99	188.2	64.8	59	244.9	84.3
20	18.9	06.5	80	75.6	26.0	40	132.4	45.6	200	189.1	65.1	60	245.8	84.6
21	19.9	06.8	81	76.6	26.4	141	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	07.2	82	77.5	26.7	42	134.3	46.2	02	191.0	65.8	62	247.7	85.3
23	21.7	07.5	83	78.5	27.0	43	135.2	46.6	03	191.9	66.1	63	248.7	85.6
24	22.7	07.8	84	79.4	27.3	44	136.2	46.9	04	192.9	66.4	64	249.6	86.0
25	23.6	08.1	85	80.4	27.7	45	137.1	47.2	05	193.8	66.7	65	250.6	86.3
26	24.6	08.5	86	81.3	28.0	46	138.0	47.5	06	194.8	67.1	66	251.5	86.6
27	25.5	08.8	87	82.3	28.3	47	139.0	47.9	07	195.7	67.4	67	252.5	86.9
28	26.5	09.1	88	83.2	28.7	48	139.9	48.2	08	196.7	67.7	68	253.4	87.3
29	27.4	09.4	89	84.2	29.0	49	140.9	48.5	09	197.6	68.0	69	254.3	87.6
30	28.4	09.8	90	85.1	29.3	50	141.8	48.8	10	198.6	68.4	70	255.3	87.9
31	29.3	10.1	91	86.0	29.6	151	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	52	143.7	49.5	12	200.4	69.0	72	257.2	88.6
33	31.2	10.7	93	87.9	30.3	53	144.7	49.8	13	201.4	69.3	73	258.1	88.9
34	32.1	11.1	94	88.9	30.6	54	145.6	50.1	14	202.3	69.7	74	259.1	89.2
35	33.1	11.4	95	89.8	30.9	55	146.6	50.5	15	203.3	70.0	75	260.0	89.5
36	34.0	11.7	96	90.8	31.3	56	147.5	50.8	16	204.2	70.3	76	261.0	89.9
37	35.0	12.0	97	91.7	31.6	57	148.4	51.1	17	205.2	70.6	77	261.9	90.2
38	35.9	12.4	98	92.7	31.9	58	149.4	51.4	18	206.1	71.0	78	262.9	90.5
39	36.9	12.7	99	93.6	32.2	59	150.3	51.8	19	207.1	71.3	79	263.8	90.8
40	37.8	13.0	100	94.6	32.6	60	151.3	52.1	20	208.0	71.6	80	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	209.0	72.0	281	265.7	91.5
42	39.7	13.7	02	96.4	33.2	62	153.2	52.7	22	209.9	72.3	82	266.6	91.8
43	40.7	14.0	03	97.4	33.5	63	154.1	53.1	23	210.9	72.6	83	267.6	92.1
44	41.6	14.3	04	98.3	33.9	64	155.1	53.4	24	211.8	72.9	84	268.5	92.5
45	42.5	14.7	05	99.3	34.2	65	156.0	53.7	25	212.7	73.3	85	269.5	92.8
46	43.5	15.0	06	100.2	34.5	66	157.0	54.0	26	213.7	73.6	86	270.4	93.1
47	44.4	15.3	07	101.2	34.8	67	157.9	54.4	27	214.6	73.9	87	271.4	93.4
48	45.4	15.6	08	102.1	35.2	68	158.8	54.7	28	215.6	74.2	88	272.3	93.8
49	46.3	16.0	09	103.1	35.5	69	159.8	55.0	29	216.5	74.6	89	273.3	94.1
50	47.3	16.3	10	104.0	35.8	70	160.7	55.3	30	217.5	74.9	90	274.2	94.4
51	48.2	16.6	111	105.0	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	12	105.9	36.5	72	162.6	56.0	32	219.4	75.5	92	276.1	95.1
53	50.1	17.3	13	106.8	36.8	73	163.6	56.3	33	220.3	75.9	93	277.0	95.4
54	51.1	17.6	14	107.8	37.1	74	164.5	56.6	34	221.3	76.2	94	278.0	95.7
55	52.0	17.9	15	108.7	37.4	75	165.5	57.0	35	222.2	76.5	95	278.9	96.0
56	52.9	18.2	16	109.7	37.8	76	166.4	57.3	36	223.1	76.8	96	279.9	96.4
57	53.9	18.6	17	110.6	38.1	77	167.4	57.6	37	224.1	77.2	97	280.8	96.7
58	54.8	18.9	18	111.6	38.4	78	168.3	58.0	38	225.0	77.5	98	281.8	97.0
59	55.8	19.2	19	112.5	38.7	79	169.2	58.3	39	226.0	77.8	99	282.7	97.3
60	56.7	19.5	20	113.5	39.1	80	170.2	58.6	40	226.9	78.1	300	283.7	97.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 71 Degrees.

TABLE II.

Difference of Latitude and Departure for 20 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.3	20.9	121	113.7	41.4	181	170.1	61.9	241	226.5	82.4
2	01.9	00.7	62	58.3	21.2	22	114.6	41.7	82	171.0	62.2	42	227.4	82.8
3	02.8	01.0	63	59.2	21.5	23	115.6	42.1	83	172.0	62.6	43	228.3	83.1
4	03.8	01.4	64	60.1	21.9	24	116.5	42.4	84	172.9	62.9	44	229.3	83.5
5	04.7	01.7	65	61.1	22.2	25	117.5	42.8	85	173.8	63.3	45	230.2	83.8
6	05.6	02.1	66	62.0	22.6	26	118.4	43.1	86	174.8	63.6	46	231.2	84.1
7	06.6	02.4	67	63.0	22.9	27	119.3	43.4	87	175.7	64.0	47	232.1	84.5
8	07.5	02.7	68	63.9	23.3	28	120.3	43.8	88	176.7	64.3	48	233.0	84.8
9	08.5	03.1	69	64.8	23.6	29	121.2	44.1	89	177.6	64.6	49	234.0	85.2
10	09.4	03.4	70	65.8	23.9	30	122.2	44.5	90	178.5	65.0	50	234.9	85.5
11	10.3	03.8	71	66.7	24.3	131	123.1	44.8	191	179.5	65.3	251	235.9	85.8
12	11.3	04.1	72	67.7	24.6	32	124.0	45.1	92	180.4	65.7	52	236.8	86.2
13	12.2	04.4	73	68.6	25.0	33	125.0	45.5	93	181.4	66.0	53	237.7	86.5
14	13.2	04.8	74	69.5	25.3	34	125.9	45.8	94	182.3	66.4	54	238.7	86.9
15	14.1	05.1	75	70.5	25.7	35	126.9	46.2	95	183.2	66.7	55	239.6	87.2
16	15.0	05.5	76	71.4	26.0	36	127.8	46.5	96	184.2	67.0	56	240.6	87.6
17	16.0	05.8	77	72.4	26.3	37	128.7	46.9	97	185.1	67.4	57	241.5	87.9
18	16.9	06.2	78	73.3	26.7	38	129.7	47.2	98	186.1	67.7	58	242.4	88.2
19	17.9	06.5	79	74.2	27.0	39	130.6	47.5	99	187.0	68.1	59	243.4	88.6
20	18.8	06.8	80	75.2	27.4	40	131.6	47.9	200	187.9	68.4	60	244.3	88.9
21	19.7	07.2	81	76.1	27.7	141	132.5	48.2	201	188.9	68.7	261	245.3	89.3
22	20.7	07.5	82	77.1	28.0	42	133.4	48.6	02	189.8	69.1	62	246.2	89.6
23	21.6	07.9	83	78.0	28.4	43	134.4	48.9	03	190.8	69.4	63	247.1	90.0
24	22.6	08.2	84	78.9	28.7	44	135.3	49.3	04	191.7	69.8	64	248.1	90.3
25	23.5	08.6	85	79.9	29.1	45	136.3	49.6	05	192.6	70.1	65	249.0	90.6
26	24.4	08.9	86	80.8	29.4	46	137.2	49.9	06	193.6	70.5	66	250.0	91.0
27	25.4	09.2	87	81.8	29.8	47	138.1	50.3	07	194.5	70.8	67	250.9	91.3
28	26.3	09.6	88	82.7	30.1	48	139.1	50.6	08	195.5	71.1	68	251.8	91.7
29	27.3	09.9	89	83.6	30.4	49	140.0	51.0	09	196.4	71.5	69	252.8	92.0
30	28.2	10.3	90	84.6	30.8	50	141.0	51.3	10	197.3	71.8	70	253.7	92.3
31	29.1	10.6	91	85.5	31.1	151	141.9	51.6	211	198.3	72.2	271	254.7	92.7
32	30.1	10.9	92	86.5	31.5	52	142.8	52.0	12	199.2	72.5	72	255.6	93.0
33	31.0	11.3	93	87.4	31.8	53	143.8	52.3	13	200.2	72.9	73	256.5	93.4
34	31.9	11.6	94	88.3	32.1	54	144.7	52.7	14	201.1	73.2	74	257.5	93.7
35	32.9	12.0	95	89.3	32.5	55	145.7	53.0	15	202.0	73.5	75	258.4	94.1
36	33.8	12.3	96	90.2	32.8	56	146.6	53.4	16	203.0	73.9	76	259.4	94.4
37	34.8	12.7	97	91.2	33.2	57	147.5	53.7	17	203.9	74.2	77	260.3	94.7
38	35.7	13.0	98	92.1	33.5	58	148.5	54.0	18	204.9	74.6	78	261.2	95.1
39	36.6	13.3	99	93.0	33.9	59	149.4	54.4	19	205.8	74.9	79	262.2	95.4
40	37.6	13.7	100	94.0	34.2	60	150.4	54.7	20	206.7	75.2	80	263.1	95.8
41	38.5	14.0	101	94.9	34.5	161	151.3	55.1	221	207.7	75.6	281	264.1	96.1
42	39.5	14.4	02	95.8	34.9	62	152.2	55.4	22	208.6	75.9	82	265.0	96.4
43	40.4	14.7	03	96.8	35.2	63	153.2	55.7	23	209.6	76.3	83	265.9	96.8
44	41.3	15.0	04	97.7	35.6	64	154.1	56.1	24	210.5	76.6	84	266.9	97.1
45	42.3	15.4	05	98.7	35.9	65	155.0	56.4	25	211.4	77.0	85	267.8	97.5
46	43.2	15.7	06	99.6	36.3	66	156.0	56.8	26	212.4	77.3	86	268.8	97.8
47	44.2	16.1	07	100.5	36.6	67	156.9	57.1	27	213.3	77.6	87	269.7	98.2
48	45.1	16.4	08	101.5	36.9	68	157.9	57.5	28	214.2	78.0	88	270.6	98.5
49	46.0	16.8	09	102.4	37.3	69	158.8	57.8	29	215.2	78.3	89	271.6	98.8
50	47.0	17.1	10	103.4	37.6	70	159.7	58.1	30	216.1	78.7	90	272.5	99.2
51	47.9	17.4	111	104.3	38.0	171	160.7	58.5	231	217.1	79.0	291	273.5	99.5
52	48.9	17.8	12	105.2	38.3	72	161.6	58.8	32	218.0	79.3	92	274.4	99.9
53	49.8	18.1	13	106.2	38.6	73	162.6	59.2	33	218.9	79.7	93	275.3	100.2
54	50.7	18.5	14	107.1	39.0	74	163.5	59.5	34	219.9	80.0	94	276.3	100.6
55	51.7	18.8	15	108.1	39.3	75	164.4	59.9	35	220.8	80.4	95	277.2	100.9
56	52.6	19.2	16	109.0	39.7	76	165.4	60.2	36	221.8	80.7	96	278.1	101.2
57	53.6	19.5	17	109.9	40.0	77	166.3	60.5	37	222.7	81.1	97	279.1	101.6
58	54.5	19.8	18	110.9	40.4	78	167.3	60.9	38	223.6	81.4	98	280.0	101.9
59	55.4	20.2	19	111.8	40.7	79	168.2	61.2	39	224.6	81.7	99	281.0	102.3
60	56.4	20.5	20	112.8	41.0	80	169.1	61.6	40	225.5	82.1	300	281.9	102.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 70 Degrees.

TABLE II.

Difference of Latitude and Departure for 21 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.9	21.9	121	113.0	43.4	181	169.0	64.9	241	225.0	86.4
2	01.9	00.7	62	57.9	22.2	22	113.9	43.7	82	169.9	65.2	42	225.9	86.7
3	02.8	01.1	63	58.8	22.6	23	114.8	44.1	83	170.8	65.6	43	226.9	87.1
4	03.7	01.4	64	59.7	22.9	24	115.8	44.4	84	171.8	65.9	44	227.8	87.4
5	04.7	01.8	65	60.7	23.3	25	116.7	44.8	85	172.7	66.3	45	228.7	87.8
6	05.6	02.2	66	61.6	23.7	26	117.6	45.2	86	173.6	66.7	46	229.7	88.2
7	06.5	02.5	67	62.5	24.0	27	118.6	45.5	87	174.6	67.0	47	230.6	88.5
8	07.5	02.9	68	63.5	24.4	28	119.5	45.9	88	175.5	67.4	48	231.5	88.9
9	08.4	03.2	69	64.4	24.7	29	120.4	46.2	89	176.4	67.7	49	232.5	89.2
10	09.3	03.6	70	65.4	25.1	30	121.4	46.6	90	177.4	68.1	50	233.4	89.6
11	10.3	03.9	71	66.3	25.4	131	122.3	46.9	191	178.3	68.4	251	234.3	90.0
12	11.2	04.3	72	67.2	25.8	32	123.2	47.3	92	179.2	68.8	52	235.3	90.3
13	12.1	04.7	73	68.2	26.2	33	124.2	47.7	93	180.2	69.2	53	236.2	90.7
14	13.1	05.0	74	69.1	26.5	34	125.1	48.0	94	181.1	69.5	54	237.1	91.0
15	14.0	05.4	75	70.0	26.9	35	126.0	48.4	95	182.0	69.9	55	238.1	91.4
16	14.9	05.7	76	71.0	27.2	36	127.0	48.7	96	183.0	70.2	56	239.0	91.7
17	15.9	06.1	77	71.9	27.6	37	127.9	49.1	97	183.9	70.6	57	239.9	92.1
18	16.8	06.5	78	72.8	28.0	38	128.8	49.5	98	184.8	71.0	58	240.9	92.5
19	17.7	06.8	79	73.8	28.3	39	129.8	49.8	99	185.8	71.3	59	241.8	92.8
20	18.7	07.2	80	74.7	28.7	40	130.7	50.2	200	186.7	71.7	60	242.7	93.2
21	19.6	07.5	81	75.6	29.0	141	131.6	50.5	201	187.6	72.0	261	243.7	93.5
22	20.5	07.9	82	76.6	29.4	42	132.6	50.9	02	188.6	72.4	62	244.6	93.9
23	21.5	08.2	83	77.5	29.7	43	133.5	51.2	03	189.5	72.7	63	245.5	94.3
24	22.4	08.6	84	78.4	30.1	44	134.4	51.6	04	190.5	73.1	64	246.5	94.6
25	23.3	09.0	85	79.4	30.5	45	135.4	52.0	05	191.4	73.5	65	247.4	95.0
26	24.3	09.3	86	80.3	30.8	46	136.3	52.3	06	192.3	73.8	66	248.3	95.3
27	25.2	09.7	87	81.2	31.2	47	137.2	52.7	07	193.3	74.2	67	249.3	95.7
28	26.1	10.0	88	82.2	31.5	48	138.2	53.0	08	194.2	74.5	68	250.2	96.0
29	27.1	10.4	89	83.1	31.9	49	139.1	53.4	09	195.1	74.9	69	251.1	96.4
30	28.0	10.8	90	84.0	32.3	50	140.0	53.8	10	196.1	75.3	70	252.1	96.8
31	28.9	11.1	91	85.0	32.6	151	141.0	54.1	211	197.0	75.6	271	253.0	97.1
32	29.9	11.5	92	85.9	33.0	52	141.9	54.5	12	197.9	76.0	72	253.9	97.5
33	30.8	11.8	93	86.8	33.3	53	142.8	54.8	13	198.9	76.3	73	254.9	97.8
34	31.7	12.2	94	87.8	33.7	54	143.8	55.2	14	199.8	76.7	74	255.8	98.2
35	32.7	12.5	95	88.7	34.0	55	144.7	55.5	15	200.7	77.0	75	256.7	98.6
36	33.6	12.9	96	89.6	34.4	56	145.6	55.9	16	201.7	77.4	76	257.7	98.9
37	34.5	13.3	97	90.6	34.8	57	146.6	56.3	17	202.6	77.8	77	258.6	99.3
38	35.5	13.6	98	91.5	35.1	58	147.5	56.6	18	203.5	78.1	78	259.5	99.6
39	36.4	14.0	99	92.4	35.5	59	148.4	57.0	19	204.5	78.5	79	260.5	100.0
40	37.3	14.3	100	93.4	35.8	60	149.4	57.3	20	205.4	78.8	80	261.4	100.3
41	38.3	14.7	101	94.3	36.2	161	150.3	57.7	221	206.3	79.2	281	262.3	100.7
42	39.2	15.1	02	95.2	36.6	62	151.2	58.1	22	207.3	79.6	82	263.3	101.1
43	40.1	15.4	03	96.2	36.9	63	152.2	58.4	23	208.2	79.9	83	264.2	101.4
44	41.1	15.8	04	97.1	37.3	64	153.1	58.8	24	209.1	80.3	84	265.1	101.8
45	42.0	16.1	05	98.0	37.6	65	154.0	59.1	25	210.1	80.6	85	266.1	102.1
46	42.9	16.5	06	99.0	38.0	66	155.0	59.5	26	211.0	81.0	86	267.0	102.5
47	43.9	16.8	07	99.9	38.3	67	155.9	59.8	27	211.9	81.3	87	267.9	102.9
48	44.8	17.2	08	100.8	38.7	68	156.8	60.2	28	212.9	81.7	88	268.9	103.2
49	45.7	17.6	09	101.8	39.1	69	157.8	60.6	29	213.8	82.1	89	269.8	103.6
50	46.7	17.9	10	102.7	39.4	70	158.7	60.9	30	214.7	82.4	90	270.7	103.9
51	47.6	18.3	111	103.6	39.8	171	159.6	61.3	231	215.7	82.8	291	271.7	104.3
52	48.5	18.6	12	104.6	40.1	72	160.6	61.6	32	216.6	83.1	92	272.6	104.6
53	49.5	19.0	13	105.5	40.5	73	161.5	62.0	33	217.5	83.5	93	273.5	105.0
54	50.4	19.4	14	106.4	40.9	74	162.4	62.4	34	218.5	83.9	94	274.5	105.4
55	51.3	19.7	15	107.4	41.2	75	163.4	62.7	35	219.4	84.2	95	275.4	105.7
56	52.3	20.1	16	108.3	41.6	76	164.3	63.1	36	220.3	84.6	96	276.3	106.1
57	53.2	20.4	17	109.2	41.9	77	165.2	63.4	37	221.3	84.9	97	277.3	106.4
58	54.1	20.8	18	110.2	42.3	78	166.2	63.8	38	222.2	85.3	98	278.2	106.8
59	55.1	21.1	19	111.1	42.6	79	167.1	64.1	39	223.1	85.6	99	279.1	107.2
60	56.0	21.5	20	112.0	43.0	80	168.0	64.5	40	224.1	86.0	300	280.1	107.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 69 Degrees.

TABLE II.

Difference of Latitude and Departure for 22 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.6	22.9	121	112.2	45.3	181	167.8	67.8	241	223.5	90.3
2	01.9	00.7	62	57.5	23.2	22	113.1	45.7	82	168.7	68.2	42	224.4	90.7
3	02.8	01.1	63	58.4	23.6	23	114.0	46.1	83	169.7	68.6	43	225.3	91.0
4	03.7	01.5	64	59.3	24.0	24	115.0	46.5	84	170.6	68.9	44	226.2	91.4
5	04.6	01.9	65	60.3	24.3	25	115.9	46.8	85	171.5	69.3	45	227.2	91.8
6	05.6	02.2	66	61.2	24.7	26	116.8	47.2	86	172.5	69.7	46	228.1	92.2
7	06.5	02.6	67	62.1	25.1	27	117.8	47.6	87	173.4	70.1	47	229.0	92.5
8	07.4	03.0	68	63.0	25.5	28	118.7	47.9	88	174.3	70.4	48	229.9	92.9
9	08.3	03.4	69	64.0	25.8	29	119.6	48.3	89	175.2	70.8	49	230.9	93.3
10	09.3	03.7	70	64.9	26.2	30	120.5	48.7	90	176.2	71.2	50	231.8	93.7
11	10.2	04.1	71	65.8	26.6	131	121.5	49.1	191	177.1	71.5	251	232.7	94.0
12	11.1	04.5	72	66.8	27.0	32	122.4	49.4	92	178.0	71.9	52	233.7	94.4
13	12.1	04.9	73	67.7	27.3	33	123.3	49.8	93	178.9	72.3	53	234.6	94.8
14	13.0	05.2	74	68.6	27.7	34	124.2	50.2	94	179.9	72.7	54	235.5	95.2
15	13.9	05.6	75	69.5	28.1	35	125.2	50.6	95	180.8	73.0	55	236.4	95.5
16	14.8	06.0	76	70.5	28.5	36	126.1	50.9	96	181.7	73.4	56	237.4	95.9
17	15.8	06.4	77	71.4	28.8	37	127.0	51.3	97	182.7	73.8	57	238.3	96.3
18	16.7	06.7	78	72.3	29.2	38	128.0	51.7	98	183.6	74.2	58	239.2	96.6
19	17.6	07.1	79	73.2	29.6	39	128.9	52.1	99	184.5	74.5	59	240.1	97.0
20	18.5	07.5	80	74.2	30.0	40	129.8	52.4	200	185.4	74.9	60	241.1	97.4
21	19.5	07.9	81	75.1	30.3	141	130.7	52.8	201	186.4	75.3	261	242.0	97.8
22	20.4	08.2	82	76.0	30.7	42	131.7	53.2	02	187.3	75.7	62	242.9	98.1
23	21.3	08.6	83	77.0	31.1	43	132.6	53.6	03	188.2	76.0	63	243.8	98.5
24	22.3	09.0	84	77.9	31.5	44	133.5	53.9	04	189.1	76.4	64	244.8	98.9
25	23.2	09.4	85	78.8	31.8	45	134.4	54.3	05	190.1	76.8	65	245.7	99.3
26	24.1	09.7	86	79.7	32.2	46	135.4	54.7	06	191.0	77.2	66	246.6	99.6
27	25.0	10.1	87	80.7	32.6	47	136.3	55.1	07	191.9	77.5	67	247.6	100.0
28	26.0	10.5	88	81.6	33.0	48	137.2	55.4	08	192.9	77.9	68	248.5	100.4
29	26.9	10.9	89	82.5	33.3	49	138.2	55.8	09	193.8	78.3	69	249.4	100.8
30	27.8	11.2	90	83.4	33.7	50	139.1	56.2	10	194.7	78.7	70	250.3	101.1
31	28.7	11.6	91	84.4	34.1	151	140.0	56.6	211	195.6	79.0	271	251.3	101.5
32	29.7	12.0	92	85.3	34.5	52	140.9	56.9	12	196.6	79.4	72	252.2	101.9
33	30.6	12.4	93	86.2	34.8	53	141.9	57.3	13	197.5	79.8	73	253.1	102.3
34	31.5	12.7	94	87.2	35.2	54	142.8	57.7	14	198.4	80.2	74	254.0	102.6
35	32.5	13.1	95	88.1	35.6	55	143.7	58.1	15	199.3	80.5	75	255.0	103.0
36	33.4	13.5	96	89.0	36.0	56	144.6	58.4	16	200.3	80.9	76	255.9	103.4
37	34.3	13.9	97	89.9	36.3	57	145.6	58.8	17	201.2	81.3	77	256.8	103.8
38	35.2	14.2	98	90.9	36.7	58	146.5	59.2	18	202.1	81.7	78	257.8	104.1
39	36.2	14.6	99	91.8	37.1	59	147.4	59.6	19	203.1	82.0	79	258.7	104.5
40	37.1	15.0	100	92.7	37.5	60	148.3	59.9	20	204.0	82.4	80	259.6	104.9
41	38.0	15.4	101	93.6	37.8	161	149.3	60.3	221	204.9	82.8	281	260.5	105.3
42	38.9	15.7	02	94.6	38.2	62	150.2	60.7	22	205.8	83.2	82	261.5	105.6
43	39.9	16.1	03	95.5	38.6	63	151.1	61.1	23	206.8	83.5	83	262.4	106.0
44	40.8	16.5	04	96.4	39.0	64	152.1	61.4	24	207.7	83.9	84	263.3	106.4
45	41.7	16.9	05	97.4	39.3	65	153.0	61.8	25	208.6	84.3	85	264.2	106.8
46	42.7	17.2	06	98.3	39.7	66	153.9	62.2	26	209.5	84.7	86	265.2	107.1
47	43.6	17.6	07	99.2	40.1	67	154.8	62.6	27	210.5	85.0	87	266.1	107.5
48	44.5	18.0	08	100.1	40.5	68	155.8	62.9	28	211.4	85.4	88	267.0	107.9
49	45.4	18.4	09	101.1	40.8	69	156.7	63.3	29	212.3	85.8	89	268.0	108.3
50	46.4	18.7	10	102.0	41.2	70	157.6	63.7	30	213.3	86.2	90	268.9	108.6
51	47.3	19.1	111	102.9	41.6	171	158.5	64.1	231	214.2	86.5	291	269.8	109.0
52	48.2	19.5	12	103.8	42.0	72	159.5	64.4	32	215.1	86.9	92	270.7	109.4
53	49.1	19.9	13	104.8	42.3	73	160.4	64.8	33	216.0	87.3	93	271.7	109.8
54	50.1	20.2	14	105.7	42.7	74	161.3	65.2	34	217.0	87.7	94	272.6	110.1
55	51.0	20.6	15	106.6	43.1	75	162.3	65.6	35	217.9	88.0	95	273.5	110.5
56	51.9	21.0	16	107.6	43.5	76	163.2	65.9	36	218.8	88.4	96	274.4	110.9
57	52.8	21.4	17	108.5	43.8	77	164.1	66.3	37	219.7	88.8	97	275.4	111.3
58	53.8	21.7	18	109.4	44.2	78	165.0	66.7	38	220.7	89.2	98	276.3	111.6
59	54.7	22.1	19	110.3	44.6	79	166.0	67.1	39	221.6	89.5	99	277.2	112.0
60	55.6	22.5	20	111.3	45.0	80	166.9	67.4	40	222.5	89.9	300	278.2	112.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 68 Degrees.

Difference of Latitude and Departure for 23 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.2	23.8	121	111.4	47.3	181	166.6	70.7	241	221.8	94.2
2	01.8	00.8	62	57.1	24.2	22	112.3	47.7	82	167.5	71.1	42	222.8	94.6
3	02.8	01.2	63	58.0	24.6	23	113.2	48.1	83	168.5	71.5	43	223.7	94.9
4	03.7	01.6	64	58.9	25.0	24	114.1	48.5	84	169.4	71.9	44	224.6	95.3
5	04.6	02.0	65	59.8	25.4	25	115.1	48.8	85	170.3	72.3	45	225.5	95.7
6	05.5	02.3	66	60.8	25.8	26	116.0	49.2	86	171.2	72.7	46	226.4	96.1
7	06.4	02.7	67	61.7	26.2	27	116.9	49.6	87	172.1	73.1	47	227.4	96.5
8	07.4	03.1	68	62.6	26.6	28	117.8	50.0	88	173.1	73.5	48	228.3	96.9
9	08.3	03.5	69	63.5	27.0	29	118.7	50.4	89	174.0	73.8	49	229.2	97.3
10	09 2	03.9	70	64.4	27.4	30	119.7	50.8	90	174.9	74.2	50	230.1	97.7
11	10.1	04.3	71	65.4	27.7	131	120.6	51.2	191	175.8	74.6	251	231.0	98.1
12	11.0	04.7	72	66.3	28.1	32	121.5	51.6	92	176.7	75.0	52	232.0	98.5
13	12.0	05.1	73	67.2	28.5	33	122.4	52.0	93	177.7	75.4	53	232.9	98.9
14	12.9	05.5	74	68.1	28.9	34	123.3	52.4	94	178.6	75.8	54	233.8	99.2
15	13.8	05.9	75	69.0	29.3	35	124.3	52.7	95	179.5	76.2	55	234.7	99.6
16	14.7	06.3	76	70.0	29.7	36	125.2	53.1	96	180.4	76.6	56	235.6	100.0
17	15.6	06.6	77	70.9	30.1	37	126.1	53.5	97	181.3	77.0	57	236.6	100.4
18	16.6	07.0	78	71.8	30.5	38	127.0	53.9	98	182.3	77.4	58	237.5	100.8
19	17.5	07.4	79	72.7	30.9	39	128.0	54.3	99	183.2	77.8	59	238.4	101.2
20	18.4	07.8	80	73.6	31.3	40	128.9	54.7	200	184.1	78.1	60	239.3	101.6
21	19.3	08.2	81	74.6	31.6	141	129.8	55.1	201	185.0	78.5	261	240.3	102.0
22	20.3	08.6	82	75.5	32.0	42	130.7	55.5	02	185.9	78.9	62	241.2	102.4
23	21.2	09.0	83	76.4	32.4	43	131.6	55.9	03	186.9	79.3	63	242.1	102.8
24	22.1	09.4	84	77.3	32.8	44	132.6	56.3	04	187.8	79.7	64	243.0	103.2
25	23.0	09.8	85	78.2	33.2	45	133.5	56.7	05	188.7	80.1	65	243.9	103.5
26	23.9	10.2	86	79.2	33.6	46	134.4	57.0	06	189.6	80.5	66	244.9	103.9
27	24.9	10.5	87	80.1	34.0	47	135.3	57.4	07	190.5	80.9	67	245.8	104.3
28	25.8	10.9	88	81.0	34.4	48	136.2	57.8	08	191.5	81.3	68	246.7	104.7
29	26.7	11.3	89	81.9	34.8	49	137.2	58.2	09	192.4	81.7	69	247.6	105.1
30	27.6	11.7	90	82.8	35.2	50	138.1	58.6	10	193.3	82.1	70	248.5	105.5
31	28.5	12.1	91	83.8	35.6	151	139.0	59.0	211	194.2	82.4	271	249.5	105.9
32	29.5	12.5	92	84.7	35.9	52	139.9	59.4	12	195.1	82.8	72	250.4	106.3
33	30.4	12.9	93	85.6	36.3	53	140.8	59.8	13	196.1	83.2	73	251.3	106.7
34	31.3	13.3	94	86.5	36.7	54	141.8	60.2	14	197.0	83.6	74	252.2	107.1
35	32.2	13.7	95	87.4	37.1	55	142.7	60.6	15	197.9	84.0	75	253.1	107.5
36	33.1	14.1	96	88.4	37.5	56	143.6	61.0	16	198.8	84.4	76	254.1	107.8
37	34.1	14.5	97	89.3	37.9	57	144.5	61.3	17	199.7	84.8	77	255.0	108.2
38	35.0	14.8	98	90.2	38.3	58	145.4	61.7	18	200.7	85.2	78	255.9	108.6
39	35.9	15.2	99	91.1	38.7	59	146.4	62.1	19	201.6	85.6	79	256.8	109.0
40	36.8	15.6	100	92.1	39.1	60	147.3	62.5	20	202.5	86.0	80	257.7	109.4
41	37.7	16.0	101	93.0	39.5	161	148.2	62.9	221	203.4	86.4	281	258.7	109.8
42	38.7	16.4	02	93.9	39.9	62	149.1	63.3	22	204.4	86.7	82	259.6	110.2
43	39.6	16.8	03	94.8	40.2	63	150.0	63.7	23	205.3	87.1	83	260.5	110.6
44	40.5	17.2	04	95.7	40.6	64	151.0	64.1	24	206.2	87.5	84	261.4	111.0
45	41.4	17.6	05	96.7	41.0	65	151.9	64.5	25	207.1	87.9	85	262.3	111.4
46	42.3	18.0	06	97.6	41.4	66	152.8	64.9	26	208.0	88.3	86	263.3	111.7
47	43.3	18.4	07	98.5	41.8	67	153.7	65.3	27	209.0	88.7	87	264.2	112.1
48	44.2	18.8	08	99.4	42.2	68	154.6	65.6	28	209.9	89.1	88	265.1	112.5
49	45.1	19.1	09	100.3	42.6	69	155.6	66.0	29	210.8	89.5	89	266.0	112.9
50	46.0	19.5	10	101.3	43.0	70	156.5	66.4	30	211.7	89.9	90	266.9	113.3
51	46.9	19.9	111	102.2	43.4	171	157.4	66.8	231	212.6	90.3	291	267.9	113.7
52	47.9	20.3	12	103.1	43.8	72	158.3	67.2	32	213.6	90.6	92	268.8	114.1
53	48.8	20.7	13	104.0	44.2	73	159.2	67.6	33	214.5	91.0	93	269.7	114.5
54	49.7	21.1	14	104.9	44.5	74	160.2	68.0	34	215.4	91.4	94	270.6	114.9
55	50.6	21.5	15	105.9	44.9	75	161.1	68.4	35	216.3	91.8	95	271.5	115.3
56	51.5	21.9	16	106.8	45.3	76	162.0	68.8	36	217.2	92.2	96	272.5	115.7
57	52.5	22.3	17	107.7	45.7	77	162.9	69.2	37	218.2	92.6	97	273.4	116.0
58	53.4	22.7	18	108.6	46.1	78	163.8	69.6	38	219.1	93.0	98	274.3	116.4
59	54.3	23.1	19	109.5	46.5	79	164.8	69.9	39	220.0	93.4	99	275.2	116.8
60	55.2	23.4	20	110.5	46.9	80	165.7	70.3	40	220.9	93.8	300	276.2	117.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 67 Degrees.

TABLE II.

Difference of Latitude and Departure for 24 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.7	24.8	121	110.5	49.2	181	165.4	73.6	241	220.2	98.0
2	01.8	00.8	62	56.6	25.2	22	111.5	49.6	82	166.3	74.0	42	221.1	98.4
3	02.7	01.2	63	57.6	25.6	23	112.4	50.0	83	167.2	74.4	43	222.0	98.8
4	03.7	01.6	64	58.5	26.0	24	113.3	50.4	84	168.1	74.8	44	222.9	99.2
5	04.6	02.0	65	59.4	26.4	25	114.2	50.8	85	169.0	75.2	45	223.8	99.7
6	05.5	02.4	66	60.3	26.8	26	115.1	51.2	86	169.9	75.7	46	224.7	100.1
7	06.4	02.8	67	61.2	27.3	27	116.0	51.7	87	170.8	76.1	47	225.6	100.5
8	07.3	03.3	68	62.1	27.7	28	116.9	52.1	88	171.7	76.5	48	226.6	100.9
9	08.2	03.7	69	63.0	28.1	29	117.8	52.5	89	172.7	76.9	49	227.5	101.3
10	09.1	04.1	70	63.9	28.5	30	118.8	52.9	90	173.6	77.3	50	228.4	101.7
11	10.0	04.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	229.3	102.1
12	11.0	04.9	72	65.8	29.3	32	120.6	53.7	92	175.4	78.1	52	230.2	102.5
13	11.9	05.3	73	66.7	29.7	33	121.5	54.1	93	176.3	78.5	53	231.1	102.9
14	12.8	05.7	74	67.6	30.1	34	122.4	54.5	94	177.2	78.9	54	232.0	103.3
15	13.7	06.1	75	68.5	30.5	35	123.3	54.9	95	178.1	79.3	55	233.0	103.7
16	14.6	06.5	76	69.4	30.9	36	124.2	55.3	96	179.1	79.7	56	233.9	104.1
17	15.5	06.9	77	70.3	31.3	37	125.2	55.7	97	180.0	80.1	57	234.8	104.5
18	16.4	07.3	78	71.3	31.7	38	126.1	56.1	98	180.9	80.5	58	235.7	104.9
19	17.4	07.7	79	72.2	32.1	39	127.0	56.5	99	181.8	80.9	59	236.6	105.3
20	18.3	08.1	80	73.1	32.5	40	127.9	56.9	200	182.7	81.3	60	237.5	105.8
21	19.2	08.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.8	261	238.4	106.2
22	20.1	08.9	82	74.9	33.4	42	129.7	57.8	02	184.5	82.2	62	239.3	106.6
23	21.0	09.4	83	75.8	33.8	43	130.6	58.2	03	185.4	82.6	63	240.3	107.0
24	21.9	09.8	84	76.7	34.2	44	131.6	58.6	04	186.4	83.0	64	241.2	107.4
25	22.8	10.2	85	77.7	34.6	45	132.5	59.0	05	187.3	83.4	65	242.1	107.8
26	23.8	10.6	86	78.6	35.0	46	133.4	59.4	06	188.2	83.8	66	243.0	108.2
27	24.7	11.0	87	79.5	35.4	47	134.3	59.8	07	189.1	84.2	67	243.9	108.6
28	25.6	11.4	88	80.4	35.8	48	135.2	60.2	08	190.0	84.6	68	244.8	109.0
29	26.5	11.8	89	81.3	36.2	49	136.1	60.6	09	190.9	85.0	69	245.7	109.4
30	27.4	12.2	90	82.2	36.6	50	137.0	61.0	10	191.8	85.4	70	246.7	109.8
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.8	85.8	271	247.6	110.2
32	29.2	13.0	92	84.0	37.4	52	138.9	61.8	12	193.7	86.2	72	248.5	110.6
33	30.1	13.4	93	85.0	37.8	53	139.8	62.2	13	194.6	86.6	73	249.4	111.0
34	31.1	13.8	94	85.9	38.2	54	140.7	62.6	14	195.5	87.0	74	250.3	111.4
35	32.0	14.2	95	86.8	38.6	55	141.6	63.0	15	196.4	87.4	75	251.2	111.9
36	32.9	14.6	96	87.7	39.0	56	142.5	63.5	16	197.3	87.9	76	252.1	112.3
37	33.8	15.0	97	88.6	39.5	57	143.4	63.9	17	198.2	88.3	77	253.1	112.7
38	34.7	15.5	98	89.5	39.9	58	144.3	64.3	18	199.2	88.7	78	254.0	113.1
39	35.6	15.9	99	90.4	40.3	59	145.3	64.7	19	200.1	89.1	79	254.9	113.5
40	36.5	16.3	100	91.4	40.7	60	146.2	65.1	20	201.0	89.5	80	255.8	113.9
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	221	201.9	89.9	281	256.7	114.3
42	38.4	17.1	02	93.2	41.5	62	148.0	65.9	22	202.8	90.3	82	257.6	114.7
43	39.3	17.5	03	94.1	41.9	63	148.9	66.3	23	203.7	90.7	83	258.5	115.1
44	40.2	17.9	04	95.0	42.3	64	149.8	66.7	24	204.6	91.1	84	259.4	115.5
45	41.1	18.3	05	95.9	42.7	65	150.7	67.1	25	205.5	91.5	85	260.4	115.9
46	42.0	18.7	06	96.8	43.1	66	151.6	67.5	26	206.5	91.9	86	261.3	116.3
47	42.9	19.1	07	97.7	43.5	67	152.6	67.9	27	207.4	92.3	87	262.2	116.7
48	43.9	19.5	08	98.7	43.9	68	153.5	68.3	28	208.3	92.7	88	263.1	117.1
49	44.8	19.9	09	99.6	44.3	69	154.4	68.7	29	209.2	93.1	89	264.0	117.5
50	45.7	20.3	10	100.5	44.7	70	155.3	69.1	30	210.1	93.5	90	264.9	118.0
51	46.6	20.7	111	101.4	45.1	171	156.2	69.6	231	211.0	94.0	291	265.8	118.4
52	47.5	21.2	12	102.3	45.6	72	157.1	70.0	32	211.9	94.4	92	266.8	118.8
53	48.4	21.6	13	103.2	46.0	73	158.0	70.4	33	212.9	94.8	93	267.7	119.2
54	49.3	22.0	14	104.1	46.4	74	159.0	70.8	34	213.8	95.2	94	268.6	119.6
55	50.2	22.4	15	105.1	46.8	75	159.9	71.2	35	214.7	95.6	95	269.5	120.0
56	51.2	22.8	16	106.0	47.2	76	160.8	71.6	36	215.6	96.0	96	270.4	120.4
57	52.1	23.2	17	106.9	47.6	77	161.7	72.0	37	216.5	96.4	97	271.3	120.8
58	53.0	23.6	18	107.8	48.0	78	162.6	72.4	38	217.4	96.8	98	272.2	121.2
59	53.9	24.0	19	108.7	48.4	79	163.5	72.8	39	218.3	97.2	99	273.2	121.6
60	54.8	24.4	20	109.6	48.8	80	164.4	73.2	40	219.3	97.6	300	274.1	122.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 66 Degrees.

Difference of Latitude and Departure for 25 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.3	25.8	121	109.7	51.1	181	164.0	76.5	241	218.4	101.9
2	01.8	00.8	62	56.2	26.2	22	110.6	51.6	82	164.9	76.9	42	219.3	102.3
3	02.7	01.3	63	57.1	26.6	23	111.5	52.0	83	165.9	77.3	43	220.2	102.7
4	03.6	01.7	64	58.0	27.0	24	112.4	52.4	84	166.8	77.8	44	221.1	103.1
5	04.5	02.1	65	58.9	27.5	25	113.3	52.8	85	167.7	78.2	45	222.0	103.5
6	05.4	02.5	66	59.8	27.9	26	114.2	53.2	86	168.6	78.6	46	223.0	104.0
7	06.3	03.0	67	60.7	28.3	27	115.1	53.7	87	169.5	79.0	47	223.9	104.4
8	07.3	03.4	68	61.6	28.7	28	116.0	54.1	88	170.4	79.5	48	224.8	104.8
9	08.2	03.8	69	62.5	29.2	29	116.9	54.5	89	171.3	79.9	49	225.7	105.2
10	09.1	04.2	70	63.4	29.6	30	117.8	54.9	90	172.2	80.3	50	226.6	105.7
11	10.0	04.6	71	64.3	30.0	131	118.7	55.4	191	173.1	80.7	251	227.5	106.1
12	10.9	05.1	72	65.3	30.4	32	119.6	55.8	92	174.0	81.1	52	228.4	106.5
13	11.8	05.5	73	66.2	30.9	33	120.5	56.2	93	174.9	81.6	53	229.3	106.9
14	12.7	05.9	74	67.1	31.3	34	121.4	56.6	94	175.8	82.0	54	230.2	107.3
15	13.6	06.3	75	68.0	31.7	35	122.4	57.1	95	176.7	82.4	55	231.1	107.8
16	14.5	06.8	76	68.9	32.1	36	123.3	57.5	96	177.6	82.8	56	232.0	108.2
17	15.4	07.2	77	69.8	32.5	37	124.2	57.9	97	178.5	83.3	57	232.9	108.6
18	16.3	07.6	78	70.7	33.0	38	125.1	58.3	98	179.4	83.7	58	233.8	109.0
19	17.2	08.0	79	71.6	33.4	39	126.0	58.7	99	180.4	84.1	59	234.7	109.5
20	18.1	08.5	80	72.5	33.8	40	126.9	59.2	200	181.3	84.5	60	235.6	109.9
21	19.0	08.9	81	73.4	34.2	141	127.8	59.6	201	182.2	84.9	261	236.5	110.3
22	19.9	09.3	82	74.3	34.7	42	128.7	60.0	02	183.1	85.4	62	237.5	110.7
23	20.8	09.7	83	75.2	35.1	43	129.6	60.4	03	184.0	85.8	63	238.4	111.1
24	21.8	10.1	84	76.1	35.5	44	130.5	60.9	04	184.9	86.2	64	239.3	111.6
25	22.7	10.6	85	77.0	35.9	45	131.4	61.3	05	185.8	86.6	65	240.2	112.0
26	23.6	11.0	86	77.9	36.3	46	132.3	61.7	06	186.7	87.1	66	241.1	112.4
27	24.5	11.4	87	78.8	36.8	47	133.2	62.1	07	187.6	87.5	67	242.0	112.8
28	25.4	11.8	88	79.8	37.2	48	134.1	62.5	08	188.5	87.9	68	242.9	113.3
29	26.3	12.3	89	80.7	37.6	49	135.0	63.0	09	189.4	88.3	69	243.3	113.7
30	27.2	12.7	90	81.6	38.0	50	135.9	63.4	10	190.3	88.7	70	244.7	114.1
31	28.1	13.1	91	82.5	38.5	151	136.9	63.8	211	191.2	89.2	271	245.6	114.5
32	29.0	13.5	92	83.4	38.9	52	137.8	64.2	12	192.1	89.6	72	246.5	115.0
33	29.9	13.9	93	84.3	39.3	53	138.7	64.7	13	193.0	90.0	73	247.4	115.4
34	30.8	14.4	94	85.2	39.7	54	139.6	65.1	14	193.9	90.4	74	248.3	115.8
35	31.7	14.8	95	86.1	40.1	55	140.5	65.5	15	194.9	90.9	75	249.2	116.2
36	32.6	15.2	96	87.0	40.6	56	141.4	65.9	16	195.8	91.3	76	250.1	116.6
37	33.5	15.6	97	87.9	41.0	57	142.3	66.4	17	196.7	91.7	77	251.0	117.1
38	34.4	16.1	98	88.8	41.4	58	143.2	66.8	18	197.6	92.1	78	252.0	117.5
39	35.3	16.5	99	89.7	41.8	59	144.1	67.2	19	198.5	92.6	79	252.9	117.9
40	36.3	16.9	100	90.6	42.3	60	145.0	67.6	20	199.4	93.0	80	253.8	118.3
41	37.2	17.3	101	91.5	42.7	161	145.9	68.0	221	200.3	93.4	281	254.7	118.8
42	38.1	17.7	02	92.4	43.1	62	146.8	68.5	22	201.2	93.8	82	255.6	119.2
43	39.0	18.2	03	93.3	43.5	63	147.7	68.9	23	202.1	94.2	83	256.5	119.6
44	39.9	18.6	04	94.3	44.0	64	148.6	69.3	24	203.0	94.7	84	257.4	120.0
45	40.8	19.0	05	95.2	44.4	65	149.5	69.7	25	203.9	95.1	85	258.3	120.4
46	41.7	19.4	06	96.1	44.8	66	150.4	70.2	26	204.8	95.5	86	259.2	120.9
47	42.6	19.9	07	97.0	45.2	67	151.4	70.6	27	205.7	95.9	87	260.1	121.3
48	43.5	20.3	08	97.9	45.6	68	152.3	71.0	28	206.6	96.4	88	261.0	121.7
49	44.4	20.7	09	98.8	46.1	69	153.2	71.4	29	207.5	96.8	89	261.9	122.1
50	45.3	21.1	10	99.7	46.5	70	154.1	71.8	30	208.5	97.2	90	262.8	122.6
51	46.2	21.6	111	100.6	46.9	171	155.0	72.3	231	209.4	97.6	291	263.7	123.0
52	47.1	22.0	12	101.5	47.3	72	155.9	72.7	32	210.3	98.0	92	264.6	123.4
53	48.0	22.4	13	102.4	47.8	73	156.8	73.1	33	211.2	98.5	93	265 5	123.8
54	48.9	22.8	14	103.3	48.2	74	157.7	73.5	34	212.1	98.9	94	266.5	124.2
55	49.8	23.2	15	104.2	48.6	75	158.6	74.0	35	213.0	99.3	95	267.4	124.7
56	50.8	23.7	16	105.1	49.0	76	159.5	74.4	36	213.9	99.7	96	268.3	125.1
57	51.7	24.1	17	106.0	49.4	77	160.4	74.8	37	214.8	100.2	97	269.2	125.5
58	52.6	24.5	18	106.9	49.9	73	161.3	75.2	38	215.7	100.6	98	270.1	125.9
59	53.5	24.9	19	107.9	50.3	79	162.2	75.6	39	216.6	101.0	99	271.0	126.4
60	54.4	25.4	20	108.8	50.7	80	163.1	76.1	40	217.5	101.4	300	271.9	126.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 65 Degrees.

TABLE II.

Difference of Latitude and Departure for 24 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.7	24.8	121	110.5	49.2	181	165.4	73.6	241	220.2	98 [illegible]
2	01.8	00.8	62	56.6	25.2	22	111.5	49.6	82	166.3	74.0	42	221.1	[illegible]
3	02.7	01.2	63	57.6	25.6	23	112.4	50.0	83	167.2	74.4	43	222.0	[illegible]
4	03.7	01.6	64	58.5	26.0	24	113.3	50.4	84	168.1	74.8	44	222.9	[illegible]
5	04.6	02.0	65	59.4	26.4	25	114.2	50.8	85	169.0	75.2	45	223.8	[illegible]
6	05.5	02.4	66	60.3	26.8	26	115.1	51.2	86	169.9	75.7	46	224.7	[illegible]
7	06.4	02.8	67	61.2	27.3	27	116.0	51.7	87	170.8	76.1	47	225.6	[illegible]
8	07.3	03.3	68	62.1	27.7	28	116.9	52.1	88	171.7	76.5	48	226 [illegible]	[illegible]
9	08.2	03.7	69	63.0	28.1	29	117.8	52.5	89	172.7	76.9	49	227 [illegible]	[illegible]
10	09.1	04.1	70	63.9	28.5	30	118.8	52.9	90	173.6	77.3	50	[illegible]	[illegible]
11	10.0	04.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	[illegible]	[illegible]
12	11.0	04.9	72	65.8	29.3	32	120.6	53.7	92	175.4	78.1	52	[illegible]	[illegible]
13	11.9	05.3	73	66.7	29.7	33	121.5	54.1	93	176.3	78.5	53	[illegible]	[illegible]
14	12.8	05.7	74	67.6	30.1	34	122.4	54.5	94	177.2	78.9	54	[illegible]	[illegible]
15	13.7	06.1	75	68.5	30.5	35	123.3	54.9	95	178.1	79.3	55	[illegible]	[illegible]
16	14.6	06.5	76	69.4	30.9	36	124.2	55.3	96	179.1	79.7	56	[illegible]	[illegible]
17	15.5	06.9	77	70.3	31.3	37	125.2	55.7	97	180.0	80.1	57	[illegible]	[illegible]
18	16.4	07.3	78	71.3	31.7	38	126.1	56.1	98	180.9	80.5	[illegible]	[illegible]	[illegible]
19	17.4	07.7	79	72.2	32.1	39	127.0	56.5	99	181.8	80.9	[illegible]	[illegible]	[illegible]
20	18.3	08.1	80	73.1	32.5	40	127.9	56.9	200	182.7	81.3	[illegible]	[illegible]	[illegible]
21	19.2	08.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.8	[illegible]	[illegible]	[illegible]
22	20.1	08.9	82	74.9	33.4	42	129.7	57.8	02	184.5	82.2	[illegible]	[illegible]	[illegible]
23	21.0	09.4	83	75.8	33.8	43	130.6	58.2	03	185.4	82.6	[illegible]	[illegible]	[illegible]
24	21.9	09.8	84	76.7	34.2	44	131.6	58.6	04	186.4	83.0	[illegible]	[illegible]	[illegible]
25	22.8	10.2	85	77.7	34.6	45	132.5	59.0	05	187.3	83.4	[illegible]	[illegible]	[illegible]
26	23.8	10.6	86	78.6	35.0	46	133.4	59.4	06	188.2	83.8	[illegible]	[illegible]	[illegible]
27	24.7	11.0	87	79.5	35.4	47	134.3	59.8	07	189.1	84.2	[illegible]	[illegible]	[illegible]
28	25.6	11.4	88	80.4	35.8	48	135.2	60.2	08	190.0	84.6	[illegible]	[illegible]	[illegible]
29	26.5	11.8	89	81.3	36.2	49	136.1	60.6	09	190.9	85.0	[illegible]	[illegible]	[illegible]
30	27.4	12.2	90	82.2	36.6	50	137.0	61.0	10	191.8	85 [illegible]	[illegible]	[illegible]	[illegible]
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.8	[illegible]	[illegible]	[illegible]	[illegible]
32	29.2	13.0	92	84.0	37.4	52	138.9	61.8	12	193.7	[illegible]	[illegible]	[illegible]	[illegible]
33	30.1	13.4	93	85.0	37.8	53	139.8	62.2	13	194.6	[illegible]	[illegible]	[illegible]	[illegible]
34	31.1	13.8	94	85.9	38.2	54	140.7	62.6	14	195.5	[illegible]	[illegible]	[illegible]	[illegible]
35	32.0	14.2	95	86.8	38.6	55	141.6	63.0	15	196.4	[illegible]	[illegible]	[illegible]	[illegible]
36	32.9	14.6	96	87.7	39.0	56	142.5	63.5	16	197 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37	33.8	15.0	97	88.6	39.5	57	143.4	63.9	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38	34.7	15.5	98	89.5	39.9	58	144.3	64.3	18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39	35.6	15.9	99	90.4	40.3	59	145.3	64.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	36.5	16.3	100	91.4	40.7	60	146.2	65.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42	38.4	17.1	02	93.2	41.5	62	148.0	65.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43	39.3	17.5	03	94.1	41.9	63	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
44	40.2	17.9	04	95.0	[illegible]	64	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
45	41.1	[illegible]	05	95.9	42.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43.1	[illegible]	151 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	97.7	43.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	46.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

27 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
							161.3	82.2	241	214.7	109.4
							162.2	82.6	42	215.6	109.9
							163.1	83.1	43	216.5	110.3
							163.9	83.5	44	217.4	110.8
							164.8	84.0	45	218.3	111.2
						6	165.7	84.4	46	219.2	111.7
						7	166.6	84.9	47	220.1	112.1
						88	167.5	85.4	48	221.0	112.6
						89	168.4	85.8	49	221.9	113.0
						90	169.3	86.3	50	222.8	113.5
						191	170.2	86.7	251	223.6	114.0
						92	171.1	87.2	52	224.5	114.4
						93	172.0	87.6	53	225.4	114.9
						94	172.9	88.1	54	226.3	115.3
						95	173.7	88.5	55	227.2	115.8
						96	174.6	89.0	56	228.1	116.2
						97	175.5	89.4	57	229.0	116.7
						98	176.4	89.9	58	229.9	117.1
						99	177.3	90.3	59	230.8	117.6
						200	178.2	90.8	60	231.7	118.0
						201	179.1	91.3	261	232.6	118.5
						02	180.0	91.7	62	233.4	118.9
						03	180.9	92.2	63	234.3	119.4
						04	181.8	92.6	64	235.2	119.9
						05	182.7	93.1	65	236.1	120.3
						06	183.5	93.5	66	237.0	120.8
						07	184.4	94.0	67	237.9	121.2
					7.2	08	185.3	94.4	68	238.8	121.7
					7.6	09	186.2	94.9	69	239.7	122.1
					68.1	10	187.1	95.3	70	240.6	122.6
					68.6	211	188.0	95.8	271	241.5	123.0
					69.0	12	188.9	96.2	72	242.4	123.5
					69.5	13	189.8	96.7	73	243.2	123.9
					69.9	14	190.7	97.2	74	244.1	124.4
				8.1	70.4	15	191.6	97.6	75	245 0	124.8
				39.0	70.8	16	192.5	98.1	76	245.9	125.3
				139.9	71.3	17	193.3	98.5	77	246.8	125.8
				140.8	71.7	18	194.2	99.0	78	247.7	126.2
			59	141.7	72.2	19	195.1	99.4	79	248.6	126.7
			60	142.6	72.6	20	196.0	99.9	80	249.5	127.1
			161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
			62	144.3	73.5	22	197.8	100.8	82	251.3	128.0
			63	145.2	74.0	23	198.7	101.2	83	252.2	128.5
		7.2	64	146.1	74.5	24	199.6	101.7	84	253.0	128.9
		7.7	65	147.0	74.9	25	200.5	102.1	85	253.9	129.4
		48.1	66	147.9	75.4	26	201.4	102.6	86	254.8	129.8
		48.6	67	148.8	75.8	27	202.3	103.1	87	255.7	130.3
		49.0	68	149.7	76.3	28	203.1	103.5	88	256.6	130.7
		49.5	69	150.6	76.7	29	204.0	104.0	89	257.5	131.2
	.0	49.9	70	151.5	77.2	30	204.9	104.4	90	258.4	131.7
	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
	99.8	50.8	72	153.3	78.1	32	206.7	105.3	92	260.2	132.6
13	100.7	51.3	73	154.1	78.5	33	207.6	105.8	93	261.1	133.0
14	101.6	51.8	74	155.0	79.0	34	208.5	106.2	94	262.0	133.5
15	102.5	52.2	75	155.9	79.4	35	209.4	106.7	95	262.8	133.9
16	103.4	52.7	76	156.8	79.9	36	210.3	107.1	96	263.7	134.4
17	104.2	53.1	77	157.7	80.4	37	211.2	107.6	97	264.6	134.8
18	105.1	53.6	78	158.6	80.8	38	212.1	108.0	98	265.5	135.3
19	106.0	54.0	79	159.5	81.3	39	213.0	108.5	99	266.4	135.7
20	106.9	54.5	80	160.4	81.7	40	213.8	109.0	300	267.3	136.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

Difference of Latitude and Departure for 26 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	54.8	26.7	121	108.8	53.0	181	162.7	79.3	241	216.6	105.6
2	01.8	00.9	62	55.7	27.2	22	109.7	53.5	82	163.6	79.8	42	217.5	106.1
3	02.7	01.3	63	56.6	27.6	23	110.6	53.9	83	164.5	80.2	43	218.4	106.5
4	03.6	01.8	64	57.5	28.1	24	111.5	54.4	84	165.4	80.7	44	219.3	107.0
5	04.5	02.2	65	58.4	28.5	25	112.3	54.8	85	166.3	81.1	45	220.2	107.4
6	05.4	02.6	66	59.3	28.9	26	113.2	55.2	86	167.2	81.5	46	221.1	107.8
7	06.3	03.1	67	60.2	29.4	27	114.1	55.7	87	168.1	82.0	47	222.0	108.3
8	07.2	03.5	68	61.1	29.8	28	115.0	56.1	88	169.0	82.4	48	222.9	108.7
9	08.1	03.9	69	62.0	30.2	29	115.9	56.5	89	169.9	82.9	49	223.8	109.2
10	09.0	04.4	70	62.9	30.7	30	116.8	57.0	90	170.8	83.3	50	224.7	109.6
11	09.9	04.8	71	63.8	31.1	131	117.7	57.4	191	171.7	83.7	251	225.6	110.0
12	10.8	05.3	72	64.7	31.6	32	118.6	57.9	92	172.6	84.2	52	226.5	110.5
13	11.7	05.7	73	65.6	32.0	33	119.5	58.3	93	173.5	84.6	53	227.4	110.9
14	12.6	06.1	74	66.5	32.4	34	120.4	58.7	94	174.4	85.0	54	228.3	111.3
15	13.5	06.6	75	67.4	32.9	35	121.3	59.2	95	175.3	85.5	55	229.2	111.8
16	14.4	07.0	76	68.3	33.3	36	122.2	59.6	96	176.2	85.9	56	230.1	112.2
17	15.3	07.5	77	69.2	33.8	37	123.1	60.1	97	177.1	86.4	57	231.0	112.7
18	16.2	07.9	78	70.1	34.2	38	124.0	60.5	98	178.0	86.8	58	231.9	113.1
19	17.1	08.3	79	71.0	34.6	39	124.9	60.9	99	178.9	87.2	59	232.8	113.5
20	18.0	08.8	80	71.9	35.1	40	125.8	61.4	200	179.8	87.7	60	233.7	114.0
21	18.9	09.2	81	72.8	35.5	141	126.7	61.8	201	180.7	88.1	261	234.6	114.4
22	19.8	09.6	82	73.7	35.9	42	127.6	62.2	02	181.6	88.6	62	235.5	114.9
23	20.7	10.1	83	74.6	36.4	43	128.5	62.7	03	182.5	89.0	63	236.4	115.3
24	21.6	10.5	84	75.5	36.8	44	129.4	63.1	04	183.4	89.4	64	237.3	115.7
25	22.5	11.0	85	76.4	37.3	45	130.3	63.6	05	184.3	89.9	65	238.2	116.2
26	23.4	11.4	86	77.3	37.7	46	131.2	64.0	06	185.2	90.3	66	239.1	116.6
27	24.3	11.8	87	78.2	38.1	47	132.1	64.4	07	186.1	90.7	67	240.0	117.0
28	25.2	12.3	88	79.1	38.6	48	133.0	64.9	08	186.9	91.2	68	240.9	117.5
29	26.1	12.7	89	80.0	39.0	49	133.9	65.3	09	187.8	91.6	69	241.8	117.9
30	27.0	13.2	90	80.9	39.5	50	134.8	65.8	10	188.7	92.1	70	242.7	118.4
31	27.9	13.6	91	81.8	39.9	151	135.7	66.2	211	189.6	92.5	271	243.6	118.8
32	28.8	14.0	92	82.7	40.3	52	136.6	66.6	12	190.5	92.9	72	244.5	119.2
33	29.7	14.5	93	83.6	40.8	53	137.5	67.1	13	191.4	93.4	73	245.4	119.7
34	30.6	14.9	94	84.5	41.2	54	138.4	67.5	14	192.3	93.8	74	246.3	120.1
35	31.5	15.3	95	85.4	41.6	55	139.3	67.9	15	193.2	94.2	75	247.2	120.6
36	32.4	15.8	96	86.3	42.1	56	140.2	68.4	16	194.1	94.7	76	248.1	121.0
37	33.3	16.2	97	87.2	42.5	57	141.1	68.8	17	195.0	95.1	77	249.0	121.4
38	34.2	16.7	98	88.1	43.0	58	142.0	69.3	18	195.9	95.6	78	249.9	121.9
39	35.1	17.1	99	89.0	43.4	59	142.9	69.7	19	196.8	96.0	79	250.8	122.3
40	36.0	17.5	100	89.9	43.8	60	143.8	70.1	20	197.7	96.4	80	251.7	122.7
41	36.9	18.0	101	90.8	44.3	161	144.7	70.6	221	198.6	96.9	281	252.6	123.2
42	37.7	18.4	02	91.7	44.7	62	145.6	71.0	22	199.5	97.3	82	253.5	123.6
43	38.6	18.8	03	92.6	45.2	63	146.5	71.5	23	200.4	97.8	83	254.4	124.1
44	39.5	19.3	04	93.5	45.6	64	147.4	71.9	24	201.3	98.2	84	255.3	124.5
45	40.4	19.7	05	94.4	46.0	65	148.3	72.3	25	202.2	98.6	85	256.2	124.9
46	41.3	20.2	06	95.3	46.5	66	149.2	72.8	26	203.1	99.1	86	257.1	125.4
47	42.2	20.6	07	96.2	46.9	67	150.1	73.2	27	204.0	99.5	87	258.0	125.8
48	43.1	21.0	08	97.1	47.3	68	151.0	73.6	28	204.9	99.9	88	258.9	126.3
49	44.0	21.5	09	98.0	47.8	69	151.9	74.1	29	205.8	100.4	89	259.8	126.7
50	44.9	21.9	10	98.9	48.2	70	152.8	74.5	30	206.7	100.8	90	260.7	127.1
51	45.8	22.4	111	99.8	48.7	171	153.7	75.0	231	207.6	101.3	291	261.5	127.6
52	46.7	22.8	12	100.7	49.1	72	154.6	75.4	32	208.5	101.7	92	262.4	128.0
53	47.6	23.2	13	101.6	49.5	73	155.5	75.8	33	209.4	102.1	93	263.3	128.4
54	48.5	23.7	14	102.5	50.0	74	156.4	76.3	34	210.3	102.6	94	264.2	128.9
55	49.4	24.1	15	103.4	50.4	75	157.3	76.7	35	211.2	103.0	95	265.1	129.3
56	50.3	24.5	16	104.3	50.9	76	158.2	77.2	36	212.1	103.5	96	266.0	129.8
57	51.2	25.0	17	105.2	51.3	77	159.1	77.6	37	213.0	103.9	97	266.9	130.2
58	52.1	25.4	18	106.1	51.7	78	160.0	78.0	38	213.9	104.3	98	267.8	130.6
59	53.0	25.9	19	107.0	52.2	79	160.9	78.5	39	214.8	104.8	99	268.7	131.1
60	53.9	26.3	20	107.9	52.6	80	161.8	78.9	40	215.7	105.2	300	269.6	131.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 64 Degrees.

TABLE II.

Difference of Latitude and Departure for 27 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	01.8	00.9	62	55.2	28.1	22	108.7	55.4	82	162.2	82.6	42	215.6	109.9
3	02.7	01.4	63	56.1	28.6	23	109.6	55.8	83	163.1	83.1	43	216.5	110.3
4	03.6	01.8	64	57.0	29.1	24	110.5	56.3	84	163.9	83.5	44	217.4	110.8
5	04.5	02.3	65	57.9	29.5	25	111.4	56.7	85	164.8	84.0	45	218.3	111.2
6	05.3	02.7	66	58.8	30.0	26	112.3	57.2	86	165.7	84.4	46	219.2	111.7
7	06.2	03.2	67	59.7	30.4	27	113.2	57.7	87	166.6	84.9	47	220.1	112.1
8	07.1	03.6	68	60.6	30.9	28	114.0	58.1	88	167.5	85.4	48	221.0	112.6
9	08.0	04.1	69	61.5	31.3	29	114.9	58.6	89	168.4	85.8	49	221.9	113.0
10	08.9	04.5	70	62.4	31.8	30	115.8	59.0	90	169.3	86.3	50	222.8	113.5
11	09.8	05.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	05.4	72	64.2	32.7	32	117.6	59.9	92	171.1	87.2	52	224.5	114.4
13	11.6	05.9	73	65.0	33.1	33	118.5	60.4	93	172.0	87.6	53	225.4	114.9
14	12.5	06.4	74	65.9	33.6	34	119.4	60.8	94	172.9	88.1	54	226.3	115.3
15	13.4	06.8	75	66.8	34.0	35	120.3	61.3	95	173.7	88.5	55	227.2	115.8
16	14.3	07.3	76	67.7	34.5	36	121.2	61.7	96	174.6	89.0	56	228.1	116.2
17	15.1	07.7	77	68.6	35.0	37	122.1	62.2	97	175.5	89.4	57	229.0	116.7
18	16.0	08.2	78	69.5	35.4	38	123.0	62.7	98	176.4	89.9	58	229.9	117.1
19	16.9	08.6	79	70.4	35.9	39	123.8	63.1	99	177.3	90.3	59	230.8	117.6
20	17.8	09.1	80	71.3	36.3	40	124.7	63.6	200	178.2	90.8	60	231.7	118.0
21	18.7	09.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	42	126.5	64.5	02	180.0	91.7	62	233.4	118.9
23	20.5	10.4	83	74.0	37.7	43	127.4	64.9	03	180.9	92.2	63	234.3	119.4
24	21.4	10.9	84	74.8	38.1	44	128.3	65.4	04	181.8	92.6	64	235.2	119.9
25	22.3	11.3	85	75.7	38.6	45	129.2	65.8	05	182.7	93.1	65	236.1	120.3
26	23.2	11.8	86	76.6	39.0	46	130.1	66.3	06	183.5	93.5	66	237.0	120.8
27	24.1	12.3	87	77.5	39.5	47	131.0	66.7	07	184.4	94.0	67	237.9	121.2
28	24.9	12.7	88	78.4	40.0	48	131.9	67.2	08	185.3	94.4	68	238.8	121.7
29	25.8	13.2	89	79.3	40.4	49	132.8	67.6	09	186.2	94.9	69	239.7	122.1
30	26.7	13.6	90	80.2	40.9	50	133.7	68.1	10	187.1	95.3	70	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.0
32	28.5	14.5	92	82.0	41.8	52	135.4	69.0	12	188.9	96.2	72	242.4	123.5
33	29.4	15.0	93	82.9	42.2	53	136.3	69.5	13	189.8	96.7	73	243.2	123.9
34	30.3	15.4	94	83.8	42.7	54	137.2	69.9	14	190.7	97.2	74	244.1	124.4
35	31.2	15.9	95	84.6	43.1	55	138.1	70.4	15	191.6	97.6	75	245.0	124.8
36	32.1	16.3	96	85.5	43.6	56	139.0	70.8	16	192.5	98.1	76	245.9	125.3
37	33.0	16.8	97	86.4	44.0	57	139.9	71.3	17	193.3	98.5	77	246.8	125.8
38	33.9	17.3	98	87.3	44.5	58	140.8	71.7	18	194.2	99.0	78	247.7	126.2
39	34.7	17.7	99	88.2	44.9	59	141.7	72.2	19	195.1	99.4	79	248.6	126.7
40	35.6	18.2	100	89.1	45.4	60	142.6	72.6	20	196.0	99.9	80	249.5	127.1
41	36.5	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
42	37.4	19.1	02	90.9	46.3	62	144.3	73.5	22	197.8	100.8	82	251.3	128.0
43	38.3	19.5	03	91.8	46.8	63	145.2	74.0	23	198.7	101.2	83	252.2	128.5
44	39.2	20.0	04	92.7	47.2	64	146.1	74.5	24	199.6	101.7	84	253.0	128.9
45	40.1	20.4	05	93.6	47.7	65	147.0	74.9	25	200.5	102.1	85	253.9	129.4
46	41.0	20.9	06	94.4	48.1	66	147.9	75.4	26	201.4	102.6	86	254.8	129.8
47	41.9	21.3	07	95.3	48.6	67	148.8	75.8	27	202.3	103.1	87	255.7	130.3
48	42.8	21.8	08	96.2	49.0	68	149.7	76.3	28	203.1	103.5	88	256.6	130.7
49	43.7	22.2	09	97.1	49.5	69	150.6	76.7	29	204.0	104.0	89	257.5	131.2
50	44.6	22.7	10	98.0	49.9	70	151.5	77.2	30	204.9	104.4	90	258.4	131.7
51	45.4	23.2	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
52	46.3	23.6	12	99.8	50.8	72	153.3	78.1	32	206.7	105.3	92	260.2	132.6
53	47.2	24.1	13	100.7	51.3	73	154.1	78.5	33	207.6	105.8	93	261.1	133.0
54	48.1	24.5	14	101.6	51.8	74	155.0	79.0	34	208.5	106.2	94	262.0	133.5
55	49.0	25.0	15	102.5	52.2	75	155.9	79.4	35	209.4	106.7	95	262.8	133.9
56	49.9	25.4	16	103.4	52.7	76	156.8	79.9	36	210.3	107.1	96	263.7	134.4
57	50.8	25.9	17	104.2	53.1	77	157.7	80.4	37	211.2	107.6	97	264.6	134.8
58	51.7	26.3	18	105.1	53.6	78	158.6	80.8	38	212.1	108.0	98	265.5	135.3
59	52.6	26.8	19	106.0	54.0	79	159.5	81.3	39	213.0	108.5	99	266.4	135.7
60	53.5	27.2	20	106.9	54.5	80	160.4	81.7	40	213.8	109.0	300	267.3	136.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

Difference of Latitude and Departure for 28 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.9	28.6	121	106.8	56.8	181	159.8	85.0	241	212.8	113.1
2	01.8	00.9	62	54.7	29.1	22	107.7	57.3	82	160.7	85.4	42	213.7	113.6
3	02.6	01.4	63	55.6	29.6	23	108.6	57.7	83	161.6	85.9	43	214.6	114.1
4	03.5	01.9	64	56.5	30.0	24	109.5	58.2	84	162.5	86.4	44	215.4	114.6
5	04.4	02.3	65	57.4	30.5	25	110.4	58.7	85	163.3	86.9	45	216.3	115.0
6	05.3	02.8	66	58.3	31.0	26	111.3	59.2	86	164.2	87.3	46	217.2	115.5
7	06.2	03.3	67	59.2	31.5	27	112.1	59.6	87	165.1	87.8	47	218.1	116.0
8	07.1	03.8	68	60.0	31.9	28	113.0	60.1	88	166.0	88.3	48	219.0	116.4
9	07.9	04.2	69	60.9	32.4	29	113.9	60.6	89	166.9	88.7	49	219.9	116.9
10	08.8	04.7	70	61.8	32.9	30	114.8	61.0	90	167.8	89.2	50	220.7	117.4
11	09.7	05.2	71	62.7	33.3	131	115.7	61.5	191	168.6	89.7	251	221.6	117.8
12	10.6	05.6	72	63.6	33.8	32	116.5	62.0	92	169.5	90.1	52	222.5	118.3
13	11.5	06.1	73	64.5	34.3	33	117.4	62.4	93	170.4	90.6	53	223.4	118.8
14	12.4	06.6	74	65.3	34.7	34	118.3	62.9	94	171.3	91.1	54	224.3	119.2
15	13.2	07.0	75	66.2	35.2	35	119.2	63.4	95	172.2	91.5	55	225.2	119.7
16	14.1	07.5	76	67.1	35.7	36	120.1	63.8	96	173.1	92.0	56	226.0	120.2
17	15.0	08.0	77	68.0	36.1	37	121.0	64.3	97	173.9	92.5	57	226.9	120.7
18	15.9	08.5	78	68.9	36.6	38	121.8	64.8	98	174.8	93.0	58	227.8	121.1
19	16.8	08.9	79	69.8	37.1	39	122.7	65.3	99	175.7	93.4	59	228.7	121.6
20	17.7	09.4	80	70.6	37.6	40	123.6	65.7	200	176.6	93.9	60	229.6	122.1
21	18.5	09.9	81	71.5	38.0	141	124.5	66.2	201	177.5	94.4	261	230.4	122.5
22	19.4	10.3	82	72.4	38.5	42	125.4	66.7	02	178.4	94.8	62	231.3	123.0
23	20.3	10.8	83	73.3	39.0	43	126.3	67.1	03	179.2	95.3	63	232.2	123.5
24	21.2	11.3	84	74.2	39.4	44	127.1	67.6	04	180.1	95.8	64	233.1	123.9
25	22.1	11.7	85	75.1	39.9	45	128.0	68.1	05	181.0	96.2	65	234.0	124.4
26	23.0	12.2	86	75.9	40.4	46	128.9	68.5	06	181.9	96.7	66	234.9	124.9
27	23.8	12.7	87	76.8	40.8	47	129.8	69.0	07	182.8	97.2	67	235.7	125.3
28	24.7	13.1	88	77.7	41.3	48	130.7	69.5	08	183.7	97.7	68	236.6	125.8
29	25.6	13.6	89	78.6	41.8	49	131.6	70.0	09	184.5	98.1	69	237.5	126.3
30	26.5	14.1	90	79.5	42.3	50	132.4	70.4	10	185.4	98.6	70	238.4	126.8
31	27.4	14.6	91	80.3	42.7	151	133.3	70.9	211	186.3	99.1	271	239.3	127.2
32	28.3	15.0	92	81.2	43.2	52	134.2	71.4	12	187.2	99.5	72	240.2	127.7
33	29.1	15.5	93	82.1	43.7	53	135.1	71.8	13	188.1	100.0	73	241.0	128.2
34	30.0	16.0	94	83.0	44.1	54	136.0	72.3	14	189.0	100.5	74	241.9	128.6
35	30.9	16.4	95	83.9	44.6	55	136.9	72.8	15	189.8	100.9	75	242.8	129.1
36	31.8	16.9	96	84.8	45.1	56	137.7	73.2	16	190.7	101.4	76	243.7	129.6
37	32.7	17.4	97	85.6	45.5	57	138.6	73.7	17	191.6	101.9	77	244.6	130.0
38	33.6	17.8	98	86.5	46.0	58	139.5	74.2	18	192.5	102.3	78	245.5	130.5
39	34.4	18.3	99	87.4	46.5	59	140.4	74.6	19	193.4	102.8	79	246.3	131.0
40	35.3	18.8	100	88.3	46.9	60	141.3	75.1	20	194.2	103.3	80	247.2	131.5
41	36.2	19.2	101	89.2	47.4	161	142.2	75.6	221	195.1	103.8	281	248.1	131.9
42	37.1	19.7	02	90.1	47.9	62	143.0	76.1	22	196.0	104.2	82	249.0	132.4
43	38.0	20.2	03	90.9	48.4	63	143.9	76.5	23	196.9	104.7	83	249.9	132.9
44	38.8	20.7	04	91.8	48.8	64	144.8	77.0	24	197.8	105.2	84	250.8	133.3
45	39.7	21.1	05	92.7	49.3	65	145.7	77.5	25	198.7	105.6	85	251.6	133.8
46	40.6	21.6	06	93.6	49.8	66	146.6	77.9	26	199.5	106.1	86	252.5	134.3
47	41.5	22.1	07	94.5	50.2	67	147.5	78.4	27	200.4	106.6	87	253.4	134.7
48	42.4	22.5	08	95.4	50.7	68	148.3	78.9	28	201.3	107.0	88	254.3	135.2
49	43.3	23.0	09	96.2	51.2	69	149.2	79.3	29	202.2	107.5	89	255.2	135.7
50	44.1	23.5	10	97.1	51.6	70	150.1	79.8	30	203.1	108.0	90	256.1	136.1
51	45.0	23.9	111	98.0	52.1	171	151.0	80.3	231	204.0	108.4	291	256.9	136.6
52	45.9	24.4	12	98.9	52.6	72	151.9	80.7	32	204.8	108.9	92	257.8	137.1
53	46.8	24.9	13	99.8	53.1	73	152.7	81.2	33	205.7	109.4	93	258.7	137.6
54	47.7	25.4	14	100.7	53.5	74	153.6	81.7	34	206.6	109.9	94	259.6	138.0
55	48.6	25.8	15	101.5	54.0	75	154.5	82.2	35	207.5	110.3	95	260.5	138.5
56	49.4	26.3	16	102.4	54.5	76	155.4	82.6	36	208.4	110.8	96	261.4	139.0
57	50.3	26.8	17	103.3	54.9	77	156.3	83.1	37	209.3	111.3	97	262.2	139.4
58	51.2	27.2	18	104.2	55.4	78	157.2	83.6	38	210.1	111.7	98	263.1	139.9
59	52.1	27.7	19	105.1	55.9	79	158.0	84.0	39	211.0	112.2	99	264.0	140.4
60	53.0	28.2	20	106.0	56.3	80	158.9	84.5	40	211.9	112.7	300	264.9	140.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 62 Degrees.

TABLE II.

Difference of Latitude and Departure for 29 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep
1	00.9	00.5	61	53.4	29.6	121	105.8	58.7	181	158.3	87.8	241	210.8	116.8
2	01.7	01.0	62	54.2	30.1	22	106.7	59.1	82	159.2	88.2	42	211.7	117.3
3	02.6	01.5	63	55.1	30.5	23	107.6	59.6	83	160.1	88.7	43	212.5	117.8
4	03.5	01.9	64	56.0	31.0	24	108.5	60.1	84	160.9	89.2	44	213.4	118.3
5	04.4	02.4	65	56.9	31.5	25	109.3	60.6	85	161.8	89.7	45	214.3	118.8
6	05.2	02.9	66	57.7	32.0	26	110.2	61.1	86	162.7	90.2	46	215.2	119.3
7	06.1	03.4	67	58.6	32.5	27	111.1	61.6	87	163.6	90.7	47	216.0	119.7
8	07.0	03.9	68	59.5	33.0	28	112.0	62.1	88	164.4	91.1	48	216.9	120.2
9	07.9	04.4	69	60.3	33.5	29	112.8	62.5	89	165.3	91.6	49	217.8	120.7
10	08.7	04.8	70	61.2	33.9	30	113.7	63.0	90	166.2	92.1	50	218.7	121.2
11	09.6	05.3	71	62.1	34.4	131	114.6	63.5	191	167.1	92.6	251	219.5	121.7
12	10.5	05.8	72	63.0	34.9	32	115.4	64.0	92	167.9	93.1	52	220.4	122.2
13	11.4	06.3	73	63.8	35.4	33	116.3	64.5	93	168.8	93.6	53	221.3	122.7
14	12.2	06.8	74	64.7	35.9	34	117.2	65.0	94	169.7	94.1	54	222.2	123.1
15	13.1	07.3	75	65.6	36.4	35	118.1	65.4	95	170.6	94.5	55	223.0	123.6
16	14.0	07.8	76	66.5	36.8	36	118.9	65.9	96	171.4	95.0	56	223.9	124.1
17	14.9	08.2	77	67.3	37.3	37	119.8	66.4	97	172.3	95.5	57	224.8	124.6
18	15.7	08.7	78	68.2	37.8	38	120.7	66.9	98	173.2	96.0	58	225.7	125.1
19	16.6	09.2	79	69.1	38.3	39	121.6	67.4	99	174.0	96.5	59	226.5	125.6
20	17.5	09.7	80	70.0	38.8	40	122.4	67.9	200	174.9	97.0	60	227.4	126.1
21	18.4	10.2	81	70.8	39.3	141	123.3	68.4	201	175.8	97.4	261	228.3	126.5
22	19.2	10.7	82	71.7	39.8	42	124.2	68.8	02	176.7	97.9	62	229.2	127.0
23	20.1	11.2	83	72.6	40.2	43	125.1	69.3	03	177.5	98.4	63	230.0	127.5
24	21.0	11.6	84	73.5	40.7	44	125.9	69.8	04	178.4	98.9	64	230.9	128.0
25	21.9	12.1	85	74.3	41.2	45	126.8	70.3	05	179.3	99.4	65	231.8	128.5
26	22.7	12.6	86	75.2	41.7	46	127.7	70.8	06	180.2	99.9	66	232.6	129.0
27	23.6	13.1	87	76.1	42.2	47	128.6	71.3	07	181.0	100.4	67	233.5	129.4
28	24.5	13.6	88	77.0	42.7	48	129.4	71.8	08	181.9	100.8	68	234.4	129.9
29	25.4	14.1	89	77.8	43.1	49	130.3	72.2	09	182.8	101.3	69	235.3	130.4
30	26.2	14.5	90	78.7	43.6	50	131.2	72.7	10	183.7	101.8	70	236.1	130.9
31	27.1	15.0	91	79.6	44.1	151	132.1	73.2	211	184.5	102.3	271	237.0	131.4
32	28.0	15.5	92	80.5	44.6	52	132.9	73.7	12	185.4	102.8	72	237.9	131.9
33	28.9	16.0	93	81.3	45.1	53	133.8	74.2	13	186.3	103.3	73	238.8	132.4
34	29.7	16.5	94	82.2	45.6	54	134.7	74.7	14	187.2	103.7	74	239.6	132.8
35	30.6	17.0	95	83.1	46.1	55	135.6	75.1	15	188.0	104.2	75	240.5	133.3
36	31.5	17.5	96	84.0	46.5	56	136.4	75.6	16	188.9	104.7	76	241.4	133.8
37	32.4	17.9	97	84.8	47.0	57	137.3	76.1	17	189.8	105.2	77	242.3	134.3
38	33.2	18.4	98	85.7	47.5	58	138.2	76.6	18	190.7	105.7	78	243.1	134.8
39	34.1	18.9	99	86.6	48.0	59	139.1	77.1	19	191.5	106.2	79	244.0	135.3
40	35.0	19.4	100	87.5	48.5	60	139.9	77.6	20	192.4	106.7	80	244.9	135.7
41	35.9	19.9	101	88.3	49.0	161	140.8	78.1	221	193.3	107.1	281	245.8	136.2
42	36.7	20.4	02	89.2	49.5	62	141.7	78.5	22	194.2	107.6	82	246.6	136.7
43	37.6	20.8	03	90.1	49.9	63	142.6	79.0	23	195.0	108.1	83	247.5	137.2
44	38.5	21.3	04	91.0	50.4	64	143.4	79.5	24	195.9	108.6	84	248.4	137.7
45	39.4	21.8	05	91.8	50.9	65	144.3	80.0	25	196.8	109.1	85	249.3	138.2
46	40.2	22.3	06	92.7	51.4	66	145.2	80.5	26	197.7	109.6	86	250.1	138.7
47	41.1	22.8	07	93.6	51.9	67	146.1	81.0	27	198.5	110.1	87	251.0	139.1
48	42.0	23.3	08	94.5	52.4	68	146.9	81.4	28	199.4	110.5	88	251.9	139.6
49	42.9	23.8	09	95.3	52.8	69	147.8	81.9	29	200.3	111.0	89	252.8	140.1
50	43.7	24.2	10	96.2	53.3	70	148.7	82.4	30	201.2	111.5	90	253.6	140.6
51	44.6	24.7	111	97.1	53.8	171	149.6	82.9	231	202.0	112.0	291	254.5	141.1
52	45.5	25.2	12	98.0	54.3	72	150.4	83.4	32	202.9	112.5	92	255.4	141.6
53	46.4	25.7	13	98.8	54.8	73	151.3	83.9	33	203.8	113.0	93	256.3	142.0
54	47.2	26.2	14	99.7	55.3	74	152.2	84.4	34	204.7	113.4	94	257.1	142.5
55	48.1	26.7	15	100.6	55.8	75	153.1	84.8	35	205.5	113.9	95	258.0	143.0
56	49.0	27.1	16	101.5	56.2	76	153.9	85.3	36	206.4	114.4	96	258.9	143.5
57	49.9	27.6	17	102.3	56.7	77	154.8	85.8	37	207.3	114.9	97	259.8	144.0
58	50.7	28.1	18	103.2	57.2	78	155.7	86.3	38	208.2	115.4	98	260.6	144.5
59	51.6	28.6	19	104.1	57.7	79	156.6	86.8	39	209.0	115.9	99	261.5	145.0
60	52.5	29.1	20	105.0	58.2	80	157.4	87.3	40	209.9	116.4	300	262.4	145.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 61 Degrees.

TABLE II.

Difference of Latitude and Departure for 30 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.8	30.5	121	104.8	60.5	181	156.8	90.5	241	208.7	120.5
2	01.7	01.0	62	53.7	31.0	22	105.7	61.0	82	157.6	91.0	42	209.6	121.0
3	02.6	01.5	63	54.6	31.5	23	106.5	61.5	83	158.5	91.5	43	210.4	121.5
4	03.5	02.0	64	55.4	32.0	24	107.4	62.0	84	159.3	92.0	44	211.3	122.0
5	04.3	02.5	65	56.3	32.5	25	108.3	62.5	85	160.2	92.5	45	212.2	122.5
6	05.2	03.0	66	57.2	33.0	26	109.1	63.0	86	161.1	93.0	46	213.0	123.0
7	06.1	03.5	67	58.0	33.5	27	110.0	63.5	87	161.9	93.5	47	213.9	123.5
8	06.9	04.0	68	58.9	34.0	28	110.9	64.0	88	162.8	94.0	48	214.8	124.0
9	07.8	04.5	69	59.8	34.5	29	111.7	64.5	89	163.7	94.5	49	215.6	124.5
10	08.7	05.0	70	60.6	35.0	30	112.6	65.0	90	164.5	95.0	50	216.5	125.0
11	09.5	05.5	71	61.5	35.5	131	113.4	65.5	191	165.4	95.5	251	217.4	125.5
12	10.4	06.0	72	62.4	36.0	32	114.3	66.0	92	166.3	96.0	52	218.2	126.0
13	11.3	06.5	73	63.2	36.5	33	115.2	66.5	93	167.1	96.5	53	219.1	126.5
14	12.1	07.0	74	64.1	37.0	34	116.0	67.0	94	168.0	97.0	54	220.0	127.0
15	13.0	07.5	75	65.0	37.5	35	116.9	67.5	95	168.9	97.5	55	220.8	127.5
16	13.9	08.0	76	65.8	38.0	36	117.8	68.0	96	169.7	98.0	56	221.7	128.0
17	14.7	08.5	77	66.7	38.5	37	118.6	68.5	97	170.6	98.5	57	222.6	128.5
18	15.6	09.0	78	67.5	39.0	38	119.5	69.0	98	171.5	99.0	58	223.4	129.0
19	16.5	09.5	79	68.4	39.5	39	120.4	69.5	99	172.3	99.5	59	224.3	129.5
20	17.3	10.0	80	69.3	40.0	40	121.2	70.0	200	173.2	100.0	60	225.2	130.0
21	18.2	10.5	81	70.1	40.5	141	122.1	70.5	201	174.1	100.5	261	226.0	130.5
22	19.1	11.0	82	71.0	41.0	42	123.0	71.0	02	174.9	101.0	62	226.9	131.0
23	19.9	11.5	83	71.9	41.5	43	123.8	71.5	03	175.8	101.5	63	227.8	131.5
24	20.8	12.0	84	72.7	42.0	44	124.7	72.0	04	176.7	102.0	64	228.6	132.0
25	21.7	12.5	85	73.6	42.5	45	125.6	72.5	05	177.5	102.5	65	229.5	132.5
26	22.5	13.0	86	74.5	43.0	46	126.4	73.0	06	178.4	103.0	66	230.4	133.0
27	23.4	13.5	87	75.3	43.5	47	127.3	73.5	07	179.3	103.5	67	231.2	133.5
28	24.2	14.0	88	76.2	44.0	48	128.2	74.0	08	180.1	104.0	68	232.1	134.0
29	25.1	14.5	89	77.1	44.5	49	129.0	74.5	09	181.0	104.5	69	233.0	134.5
30	26.0	15.0	90	77.9	45.0	50	129.9	75.0	10	181.9	105.0	70	233.8	135.0
31	26.8	15.5	91	78.8	45.5	151	130.8	75.5	211	182.7	105.5	271	234.7	135.5
32	27.7	16.0	92	79.7	46.0	52	131.6	76.0	12	183.6	106.0	72	235.6	136.0
33	28.6	16.5	93	80.5	46.5	53	132.5	76.5	13	184.5	106.5	73	236.4	136.5
34	29.4	17.0	94	81.4	47.0	54	133.4	77.0	14	185.3	107.0	74	237.3	137.0
35	30.3	17.5	95	82.3	47.5	55	134.2	77.5	15	186.2	107.5	75	238.2	137.5
36	31.2	18.0	96	83.1	48.0	56	135.1	78.0	16	187.1	108.0	76	239.0	138.0
37	32.0	18.5	97	84.0	48.5	57	136.0	78.5	17	187.9	108.5	77	239.9	138.5
38	32.9	19.0	98	84.9	49.0	58	136.8	79.0	18	188.8	109.0	78	240.8	139.0
39	33.8	19.5	99	85.7	49.5	59	137.7	79.5	19	189.7	109.5	79	241.6	139.5
40	34.6	20.0	100	86.6	50.0	60	138.6	80.0	20	190.5	110.0	80	242.5	140.0
41	35.5	20.5	101	87.5	50.5	161	139.4	80.5	221	191.4	110.5	281	243.4	140.5
42	36.4	21.0	02	88.3	51.0	62	140.3	81.0	22	192.3	111.0	82	244.2	141.0
43	37.2	21.5	03	89.2	51.5	63	141.2	81.5	23	193.1	111.5	83	245.1	141.5
44	38.1	22.0	04	90.1	52.0	64	142.0	82.0	24	194.0	112.0	84	246.0	142.0
45	39.0	22.5	05	90.9	52.5	65	142.9	82.5	25	194.9	112.5	85	246.8	142.5
46	39.8	23.0	06	91.8	53.0	66	143.8	83.0	26	195.7	113.0	86	247.7	143.0
47	40.7	23.5	07	92.7	53.5	67	144.6	83.5	27	196.6	113.5	87	248.5	143.5
48	41.6	24.0	08	93.5	54.0	68	145.5	84.0	28	197.5	114.0	88	249.4	144.0
49	42.4	24.5	09	94.4	54.5	69	146.4	84.5	29	198.3	114.5	89	250.3	144.5
50	43.3	25.0	10	95.3	55.0	70	147.2	85.0	30	199.2	115.0	90	251.1	145.0
51	44.2	25.5	111	96.1	55.5	171	148.1	85.5	231	200.1	115.5	291	252.0	145.5
52	45.0	26.0	12	97.0	56.0	72	149.0	86.0	32	200.9	116.0	92	252.9	146.0
53	45.9	26.5	13	97.9	56.5	73	149.8	86.5	33	201.8	116.5	93	253.7	146.5
54	46.8	27.0	14	98.7	57.0	74	150.7	87.0	34	202.6	117.0	94	254.6	147.0
55	47.6	27.5	15	99.6	57.5	75	151.6	87.5	35	203.5	117.5	95	255.5	147.5
56	48.5	28.0	16	100.5	58.0	76	152.4	88.0	36	204.4	118.0	96	256.3	148.0
57	49.4	28.5	17	101.3	58.5	77	153.3	88.5	37	205.2	118.5	97	257.2	148.5
58	50.2	29.0	18	102.2	59.0	78	154.2	89.0	38	206.1	119.0	98	258.1	149.0
59	51.1	29.5	19	103.1	59.5	79	155.0	89.5	39	207.0	119.5	99	258.9	149.5
60	52.0	30.0	20	103.9	60.0	80	155.9	90.0	40	207.8	120.0	300	259.8	150.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 60 Degrees.

TABLE II.

Difference of Latitude and Departure for 31 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.7	62.3	181	155.1	93.2	241	206.6	124.1
2	01.7	01.0	62	53.1	31.9	22	104.6	62.8	82	156.0	93.7	42	207.4	124.6
3	02.6	01.5	63	54.0	32.4	23	105.4	63.3	83	156.9	94.3	43	208.3	125.2
4	03.4	02.1	64	54.9	33.0	24	106.3	63.9	84	157.7	94.8	44	209.1	125.7
5	04.3	02.6	65	55.7	33.5	25	107.1	64.4	85	158.6	95.3	45	210.0	126.2
6	05.1	03.1	66	56.6	34.0	26	108.0	64.9	86	159.4	95.8	46	210.9	126.7
7	06.0	03.6	67	57.4	34.5	27	108.9	65.4	87	160.3	96.3	47	211.7	127.2
8	06.9	04.1	68	58.3	35.0	28	109.7	65.9	88	161.1	96.8	48	212.6	127.7
9	07.7	04.6	69	59.1	35.5	29	110.6	66.4	89	162.0	97.3	49	213.4	128.2
10	08.6	05.2	70	60.0	36.1	30	111.4	67.0	90	162.9	97.9	50	214.3	128.8
11	09.4	05.7	71	60.9	36.6	131	112.3	67.5	191	163.7	98.4	251	215.1	129.3
12	10.3	06.2	72	61.7	37.1	32	113.1	68.0	92	164.6	98.9	52	216.0	129.8
13	11.1	06.7	73	62.6	37.6	33	114.0	68.5	93	165.4	99.4	53	216.9	130.3
14	12.0	07.2	74	63.4	38.1	34	114.9	69.0	94	166.3	99.9	54	217.7	130.8
15	12.9	07.7	75	64.3	38.6	35	115.7	69.5	95	167.1	100.4	55	218.6	131.3
16	13.7	08.2	76	65.1	39.1	36	116.6	70.0	96	168.0	100.9	56	219.4	131.8
17	14.6	08.8	77	66.0	39.7	37	117.4	70.6	97	168.9	101.5	57	220.3	132.4
18	15.4	09.3	78	66.9	40.2	38	118.3	71.1	98	169.7	102.0	58	221.1	132.9
19	16.3	09.8	79	67.7	40.7	39	119.1	71.6	99	170.6	102.5	59	222.0	133.4
20	17.1	10.3	80	68.6	41.2	40	120.0	72.1	200	171.4	103.0	60	222.9	133.9
21	18.0	10.8	81	69.4	41.7	141	120.9	72.6	201	172.3	103.5	261	223.7	134.4
22	18.9	11.3	82	70.3	42.2	42	121.7	73.1	02	173.1	104.0	62	224.6	134.9
23	19.7	11.8	83	71.1	42.7	43	122.6	73.7	03	174.0	104.6	63	225.4	135.5
24	20.6	12.4	84	72.0	43.3	44	123.4	74.2	04	174.9	105.1	64	226.3	136.0
25	21.4	12.9	85	72.9	43.8	45	124.3	74.7	05	175.7	105.6	65	227.1	136.5
26	22.3	13.4	86	73.7	44.3	46	125.1	75.2	06	176.6	106.1	66	228.0	137.0
27	23.1	13.9	87	74.6	44.8	47	126.0	75.7	07	177.4	106.6	67	228.9	137.5
28	24.0	14.4	88	75.4	45.3	48	126.9	76.2	08	178.3	107.1	68	229.7	138.0
29	24.9	14.9	89	76.3	45.8	49	127.7	76.7	09	179.1	107.6	69	230.6	138.5
30	25.7	15.5	90	77.1	46.4	50	128.6	77.3	10	180.0	108.2	70	231.4	139.1
31	26.6	16.0	91	78.0	46.9	151	129.4	77.8	211	180.9	108.7	271	232.3	139.6
32	27.4	16.5	92	78.9	47.4	52	130.3	78.3	12	181.7	109.2	72	233.1	140.1
33	28.3	17.0	93	79.7	47.9	53	131.1	78.8	13	182.6	109.7	73	234.0	140.6
34	29.1	17.5	94	80.6	48.4	54	132.0	79.3	14	183.4	110.2	74	234.9	141.1
35	30.0	18.0	95	81.4	48.9	55	132.9	79.8	15	184.3	110.7	75	235.7	141.6
36	30.9	18.5	96	82.3	49.4	56	133.7	80.3	16	185.1	111.2	76	236.6	142.2
37	31.7	19.1	97	83.1	50.0	57	134.6	80.9	17	186.0	111.8	77	237.4	142.7
38	32.6	19.6	98	84.0	50.5	58	135.4	81.4	18	186.9	112.3	78	238.3	143.2
39	33.4	20.1	99	84.9	51.0	59	136.3	81.9	19	187.7	112.8	79	239.1	143.7
40	34.3	20.6	100	85.7	51.5	60	137.1	82.4	20	188.6	113.3	80	240.0	144.2
41	35.1	21.1	101	86.6	52.0	161	138.0	82.9	221	189.4	113.8	281	240.9	144.7
42	36.0	21.6	02	87.4	52.5	62	138.9	83.4	22	190.3	114.3	82	241.7	145.2
43	36.9	22.1	03	88.3	53.0	63	139.7	84.0	23	191.1	114.9	83	242.6	145.8
44	37.7	22.7	04	89.1	53.6	64	140.6	84.5	24	192.0	115.4	84	243.4	146.3
45	38.6	23.2	05	90.0	54.1	65	141.4	85.0	25	192.9	115.9	85	244.3	146.8
46	39.4	23.7	06	90.9	54.6	66	142.3	85.5	26	193.7	116.4	86	245.1	147.3
47	40.3	24.2	07	91.7	55.1	67	143.1	86.0	27	194.6	116.9	87	246.0	147.8
48	41.1	24.7	08	92.6	55.6	68	144.0	86.5	28	195.4	117.4	88	246.9	148.3
49	42.0	25.2	09	93.4	56.1	69	144.9	87.0	29	196.3	117.9	89	247.7	148.8
50	42.9	25.8	10	94.3	56.7	70	145.7	87.6	30	197.1	118.5	90	248.6	149.4
51	43.7	26.3	111	95.1	57.2	171	146.6	88.1	231	198.0	119.0	291	249.4	149.9
52	44.6	26.8	12	96.0	57.7	72	147.4	88.6	32	198.9	119.5	92	250.3	150.4
53	45.4	27.3	13	96.9	58.2	73	148.3	89.1	33	199.7	120.0	93	251.2	150.9
54	46.3	27.8	14	97.7	58.7	74	149.1	89.6	34	200.6	120.5	94	252.0	151.4
55	47.1	28.3	15	98.6	59.2	75	150.0	90.1	35	201.4	121.0	95	252.9	151.9
56	48.0	28.8	16	99.4	59.7	76	150.9	90.6	36	202.3	121.5	96	253.7	152.5
57	48.9	29.4	17	100.3	60.3	77	151.7	91.2	37	203.1	122.1	97	254.6	153.0
58	49.7	29.9	18	101.1	60.8	78	152.6	91.7	38	204.0	122.6	98	255.4	153.5
59	50.6	30.4	19	102.0	61.3	79	153.4	92.2	39	204.9	123.1	99	256.3	154.0
60	51.4	30.9	20	102.9	61.8	80	154.3	92.7	40	205.7	123.6	300	257.1	154.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 59 Degrees.

TABLE II.

Difference of Latitude and Departure for 32 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.5	61	51.7	32.3	121	102.6	64.1	181	153.5	95.9	241	204.4	127.7
2	01.7	01.1	62	52.6	32.9	22	103.5	64.7	82	154.3	96.4	42	205.2	128.2
3	02.5	01.6	63	53.4	33.4	23	104.3	65.2	83	155.2	97.0	43	206.1	128.8
4	03.4	02.1	64	54.3	33.9	24	105.2	65.7	84	156.0	97.5	44	206.9	129.3
5	04.2	02.6	65	55.1	34.4	25	106.0	66.2	85	156.9	98.0	45	207.8	129.8
6	05.1	03.2	66	56.0	35.0	26	106.9	66.8	86	157.7	98.6	46	208.6	130.4
7	05.9	03.7	67	56.8	35.5	27	107.7	67.3	87	158.6	99.1	47	209.5	130.9
8	06.8	04.2	68	57.7	36.0	28	108.6	67.8	88	159.4	99.6	48	210.3	131.4
9	07.6	04.8	69	58.5	36.6	29	109.4	68.4	89	160.3	100.2	49	211.2	131.9
10	08.5	05.3	70	59.4	37.1	30	110.2	68.9	90	161.1	100.7	50	212.0	132.5
11	09.3	05.8	71	60.2	37.6	131	111.1	69.4	191	162.0	101.2	251	212.9	133.0
12	10.2	06.4	72	61.1	38.2	32	111.9	69.9	92	162.8	101.7	52	213.7	133.5
13	11.0	06.9	73	61.9	38.7	33	112.8	70.5	93	163.7	102.3	53	214.6	134.1
14	11.9	07.4	74	62.8	39.2	34	113.6	71.0	94	164.5	102.8	54	215.4	134.6
15	12.7	07.9	75	63.6	39.7	35	114.5	71.5	95	165.4	103.3	55	216.3	135.1
16	13.6	08.5	76	64.5	40.3	36	115.3	72.1	96	166.2	103.9	56	217.1	135.7
17	14.4	09.0	77	65.3	40.8	37	116.2	72.6	97	167.1	104.4	57	217.9	136.2
18	15.3	09.5	78	66.1	41.3	38	117.0	73.1	98	167.9	104.9	58	218.8	136.7
19	16.1	10.1	79	67.0	41.9	39	117.9	73.7	99	168.8	105.5	59	219.6	137.2
20	17.0	10.6	80	67.8	42.4	40	118.7	74.2	200	169.6	106.0	60	220.5	137.8
21	17.8	11.1	81	68.7	42.9	141	119.6	74.7	201	170.5	106.5	261	221.3	138.3
22	18.7	11.7	82	69.5	43.5	42	120.4	75.2	02	171.3	107.0	62	222.2	138.8
23	19.5	12.2	83	70.4	44.0	43	121.3	75.8	03	172.2	107.6	63	223.0	139.4
24	20.4	12.7	84	71.2	44.5	44	122.1	76.3	04	173.0	108.1	64	223.9	139.9
25	21.2	13.2	85	72.1	45.0	45	123.0	76.8	05	173.8	108.6	65	224.7	140.4
26	22.0	13.8	86	72.9	45.6	46	123.8	77.4	06	174.7	109.2	66	225.6	141.0
27	22.9	14.3	87	73.8	46.1	47	124.7	77.9	07	175.5	109.7	67	226.4	141.5
28	23.7	14.8	88	74.6	46.6	48	125.5	78.4	08	176.4	110.2	68	227.3	142.0
29	24.6	15.4	89	75.5	47.2	49	126.4	79.0	09	177.2	110.8	69	228.1	142.5
30	25.4	15.9	90	76.3	47.7	50	127.2	79.5	10	178.1	111.3	70	229.0	143.1
31	26.3	16.4	91	77.2	48.2	151	128.1	80.0	211	178.9	111.8	271	229.8	143.6
32	27.1	17.0	92	78.0	48.8	52	128.9	80.5	12	179.8	112.3	72	230.7	144.1
33	28.0	17.5	93	78.9	49.3	53	129.8	81.1	13	180.6	112.9	73	231.5	144.7
34	28.8	18.0	94	79.7	49.8	54	130.6	81.6	14	181.5	113.4	74	232.4	145.2
35	29.7	18.5	95	80.6	50.3	55	131.4	82.1	15	182.3	113.9	75	233.2	145.7
36	30.5	19.1	96	81.4	50.9	56	132.3	82.7	16	183.2	114.5	76	234.1	146.3
37	31.4	19.6	97	82.3	51.4	57	133.1	83.2	17	184.0	115.0	77	234.9	146.8
38	32.2	20.1	98	83.1	51.9	58	134.0	83.7	18	184.9	115.5	78	235.8	147.3
39	33.1	20.7	99	84.0	52.5	59	134.8	84.3	19	185.7	116.1	79	236.6	147.8
40	33.9	21.2	100	84.8	53.0	60	135.7	84.8	20	186.6	116.6	80	237.5	148.4
41	34.8	21.7	101	85.7	53.5	161	136.5	85.3	221	187.4	117.1	281	238.3	148.9
42	35.6	22.3	02	86.5	54.1	62	137.4	85.8	22	188.3	117.6	82	239.1	149.4
43	36.5	22.8	03	87.3	54.6	63	138.2	86.4	23	189.1	118.2	83	240.0	150.0
44	37.3	23.3	04	88.2	55.1	64	139.1	86.9	24	190.0	118.7	84	240.8	150.5
45	38.2	23.8	05	89.0	55.6	65	139.9	87.4	25	190.8	119.2	85	241.7	151.0
46	39.0	24.4	06	89.9	56.2	66	140.8	88.0	26	191.7	119.8	86	242.5	151.6
47	39.9	24.9	07	90.7	56.7	67	141.6	88.5	27	192.5	120.3	87	243.4	152.1
48	40.7	25.4	08	91.6	57.2	68	142.5	89.0	28	193.4	120.8	88	244.2	152.6
49	41.6	26.0	09	92.4	57.8	69	143.3	89.6	29	194.2	121.4	89	245.1	153.1
50	42.4	26.5	10	93.3	58.3	70	144.2	90.1	30	195.1	121.9	90	245.9	153.7
51	43.3	27.0	111	94.1	58.8	171	145.0	90.6	231	195.9	122.4	291	246.8	154.2
52	44.1	27.6	12	95.0	59.4	72	145.9	91.1	32	196.7	122.9	92	247.6	154.7
53	44.9	28.1	13	95.8	59.9	73	146.7	91.7	33	197.6	123.5	93	248.5	155.3
54	45.8	28.6	14	96.7	60.4	74	147.6	92.2	34	198.4	124.0	94	249.3	155.8
55	46.6	29.1	15	97.5	60.9	75	148.4	92.7	35	199.3	124.5	95	250.2	156.3
56	47.5	29.7	16	98.4	61.5	76	149.3	93.3	36	200.1	125.1	96	251.0	156.9
57	48.3	30.2	17	99.2	62.0	77	150.1	93.8	37	201.0	125.6	97	251.9	157.4
58	49.2	30.7	18	100.1	62.5	78	151.0	94.3	38	201.8	126.1	98	252.7	157.9
59	50.0	31.3	19	100.9	63.1	79	151.8	94.9	39	202.7	126.7	99	253.6	158.4
60	50.9	31.8	20	101.8	63.6	80	152.6	95.4	40	203.5	127.2	300	254.4	159.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 58 Degrees.

Difference of Latitude and Departure for 33 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.5	61	51.2	33.2	121	101.5	65.9	181	151.8	98.6	241	202.1	131.3
2	01.7	01.1	62	52.0	33.8	22	102.3	66.4	82	152.6	99.1	42	203.0	131.8
3	02.5	01.6	63	52.8	34.3	23	103.2	67.0	83	153.5	99.7	43	203.8	132.3
4	03.4	02.2	64	53.7	34.9	24	104.0	67.5	84	154.3	100.2	44	204.6	132.9
5	04.2	02.7	65	54.5	35.4	25	104.8	68.1	85	155.2	100.8	45	205.5	133.4
6	05.0	03.3	66	55.4	35.9	26	105.7	68.6	86	156.0	101.3	46	206.3	134.0
7	05.9	03.8	67	56.2	36.5	27	106.5	69.2	87	156.8	101.8	47	207.2	134.5
8	06.7	04.4	68	57.0	37.0	28	107.3	69.7	88	157.7	102.4	48	208.0	135.1
9	07.5	04.9	69	57.9	37.6	29	108.2	70.3	89	158.5	102.9	49	208.8	135.6
10	08.4	05.4	70	58.7	38.1	30	109.0	70.8	90	159.3	103.5	50	209.7	136.2
11	09.2	06.0	71	59.5	38.7	131	109.9	71.3	191	160.2	104.0	251	210.5	136.7
12	10.1	06.5	72	60.4	39.2	32	110.7	71.9	92	161.0	104.6	52	211.3	137.2
13	10.9	07.1	73	61.2	39.8	33	111.5	72.4	93	161.9	105.1	53	212.2	137.8
14	11.7	07.6	74	62.1	40.3	34	112.4	73.0	94	162.7	105.7	54	213.0	138.3
15	12.6	08.2	75	62.9	40.8	35	113.2	73.5	95	163.5	106.2	55	213.9	138.9
16	13.4	08.7	76	63.7	41.4	36	114.1	74.1	96	164.4	106.7	56	214.7	139.4
17	14.3	09.3	77	64.6	41.9	37	114.9	74.6	97	165.2	107.3	57	215.5	140.0
18	15.1	09.8	78	65.4	42.5	38	115.7	75.2	98	166.1	107.8	58	216.4	140.5
19	15.9	10.3	79	66.3	43.0	39	116.6	75.7	99	166.9	108.4	59	217.2	141.1
20	16.8	10.9	80	67.1	43.6	40	117.4	76.2	200	167.7	108.9	60	218.1	141.6
21	17.6	11.4	81	67.9	44.1	141	118.3	76.8	201	168.6	109.5	261	218.9	142.2
22	18.5	12.0	82	68.8	44.7	42	119.1	77.3	02	169.4	110.0	62	219.7	142.7
23	19.3	12.5	83	69.6	45.2	43	119.9	77.9	03	170.3	110.6	63	220.6	143.2
24	20.1	13.1	84	70.4	45.7	44	120.8	78.4	04	171.1	111.1	64	221.4	143.8
25	21.0	13.6	85	71.3	46.3	45	121.6	79.0	05	171.9	111.7	65	222.2	144.3
26	21.8	14.2	86	72.1	46.8	46	122.4	79.5	06	172.8	112.2	66	223.1	144.9
27	22.6	14.7	87	73.0	47.4	47	123.3	80.1	07	173.6	112.7	67	223.9	145.4
28	23.5	15.2	88	73.8	47.9	48	124.1	80.6	08	174.4	113.3	68	224.8	146.0
29	24.3	15.8	89	74.6	48.5	49	125.0	81.2	09	175.3	113.8	69	225.6	146.5
30	25.2	16.3	90	75.5	49.0	50	125.8	81.7	10	176.1	114.4	70	226.4	147.1
31	26.0	16.9	91	76.3	49.6	151	126.6	82.2	211	177.0	114.9	271	227.3	147.6
32	26.8	17.4	92	77.2	50.1	52	127.5	82.8	12	177.8	115.5	72	228.1	148.1
33	27.7	18.0	93	78.0	50.7	53	128.3	83.3	13	178.6	116.0	73	229.0	148.7
34	28.5	18.5	94	78.8	51.2	54	129.2	83.9	14	179.5	116.6	74	229.8	149.2
35	29.4	19.1	95	79.7	51.7	55	130.0	84.4	15	180.3	117.1	75	230.6	149.8
36	30.2	19.6	96	80.5	52.3	56	130.8	85.0	16	181.2	117.6	76	231.5	150.3
37	31.0	20.2	97	81.4	52.8	57	131.7	85.5	17	182.0	118.2	77	232.3	150.9
38	31.9	20.7	98	82.2	53.4	58	132.5	86.1	18	182.8	118.7	78	233.2	151.4
39	32.7	21.2	99	83.0	53.9	59	133.3	86.6	19	183.7	119.3	79	234.0	152.0
40	33.5	21.8	100	83.9	54.5	60	134.2	87.1	20	184.5	119.8	80	234.8	152.5
41	34.4	22.3	101	84.7	55.0	161	135.0	87.7	221	185.3	120.4	281	235.7	153.0
42	35.2	22.9	02	85.5	55.6	62	135.9	88.2	22	186.2	120.9	82	236.5	153.6
43	36.1	23.4	03	86.4	56.1	63	136.7	88.8	23	187.0	121.5	83	237.3	154.1
44	36.9	24.0	04	87.2	56.6	64	137.5	89.3	24	187.9	122.0	84	238.2	154.7
45	37.7	24.5	05	88.1	57.2	65	138.4	89.9	25	188.7	122.5	85	239.0	155.2
46	38.6	25.1	06	88.9	57.7	66	139.2	90.4	26	189.5	123.1	86	239.9	155.8
47	39.4	25.6	07	89.7	58.3	67	140.1	91.0	27	190.4	123.6	87	240.7	156.3
48	40.3	26.1	08	90.6	58.8	68	140.9	91.5	28	191.2	124.2	88	241.5	156.9
49	41.1	26.7	09	91.4	59.4	69	141.7	92.0	29	192.1	124.7	89	242.4	157.4
50	41.9	27.2	10	92.3	59.9	70	142.6	92.6	30	192.9	125.3	90	243.2	157.9
51	42.8	27.8	111	93.1	60.5	171	143.4	93.1	231	193.7	125.8	291	244.1	158.5
52	43.6	28.3	12	93.9	61.0	72	144.3	93.7	32	194.6	126.4	92	244.9	159.0
53	44.4	28.9	13	94.8	61.5	73	145.1	94.2	33	195.4	126.9	93	245.7	159.6
54	45.3	29.4	14	95.6	62.1	74	145.9	94.8	34	196.2	127.4	94	246.6	160.1
55	46.1	30.0	15	96.4	62.6	75	146.8	95.3	35	197.1	128.0	95	247.4	160.7
56	47.0	30.5	16	97.3	63.2	76	147.6	95.9	36	197.9	128.5	96	248.2	161.2
57	47.8	31.0	17	98.1	63.7	77	148.4	96.4	37	198.8	129.1	97	249.1	161.8
58	48.6	31.6	18	99.0	64.3	78	149.3	96.9	38	199.6	129.6	98	249.9	162.3
59	49.5	32.1	19	99.8	64.8	79	150.1	97.5	39	200.4	130.2	99	250.8	162.8
60	50.3	32.7	20	100.6	65.4	80	151.0	98.0	40	201.3	130.7	300	251.6	163.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 57 Degrees

TABLE II.

Difference of Latitude and Departure for 34 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.6	34.1	121	100.3	67.7	181	150.1	101.2	241	199.8	134.8
2	01.7	01.1	62	51.4	34.7	22	101.1	68.2	82	150.9	101.8	42	200.6	135.3
3	02.5	01.7	63	52.2	35.2	23	102.0	68.8	83	151.7	102.3	43	201.5	135.9
4	03.3	02.2	64	53.1	35.8	24	102.8	69.3	84	152.5	102.9	44	202.3	136.4
5	04.1	02.8	65	53.9	36.3	25	103.6	69.9	85	153.4	103.5	45	203.1	137.0
6	05.0	03.4	66	54.7	36.9	26	104.5	70.5	86	154.2	104.0	46	203.9	137.6
7	05.8	03.9	67	55.5	37.5	27	105.3	71.0	87	155.0	104.6	47	204.8	138.1
8	06.6	04.5	68	56.4	38.0	28	106.1	71.6	88	155.9	105.1	48	205.6	138.7
9	07.5	05.0	69	57.2	38.6	29	106.9	72.1	89	156.7	105.7	49	206.4	139.2
10	08.3	05.6	70	58.0	39.1	30	107.8	72.7	90	157.5	106.2	50	207.3	139.8
11	09.1	06.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	09.9	06.7	72	59.7	40.3	32	109.4	73.8	92	159.2	107.4	52	208.9	140.9
13	10.8	07.3	73	60.5	40.8	33	110.3	74.4	93	160.0	107.9	53	209.7	141.5
14	11.6	07.8	74	61.3	41.4	34	111.1	74.9	94	160.8	108.5	54	210.6	142.0
15	12.4	08.4	75	62.2	41.9	35	111.9	75.5	95	161.7	109.0	55	211.4	142.6
16	13.3	08.9	76	63.0	42.5	36	112.7	76.1	96	162.5	109.6	56	212.2	143.2
17	14.1	09.5	77	63.8	43.1	37	113.6	76.6	97	163.3	110.2	57	213.1	143.7
18	14.9	10.1	78	64.7	43.6	38	114.4	77.2	98	164.1	110.7	58	213.9	144.3
19	15.8	10.6	79	65.5	44.2	69	115.2	77.7	99	165.0	111.3	59	214.7	144.8
20	16.6	11.2	80	66.3	44.7	40	116.1	78.3	200	165.8	111.8	60	215.5	145.4
21	17.4	11.7	81	67.2	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	145.9
22	18.2	12.3	82	68.0	45.9	42	117.7	79.4	02	167.5	113.0	62	217.2	146.5
23	19.1	12.9	83	68.8	46.4	43	118.6	80.0	03	168.3	113.5	63	218.0	147.1
24	19.9	13.4	84	69.6	47.0	44	119.4	80.5	04	169.1	114.1	64	218.9	147.6
25	20.7	14.0	85	70.5	47.5	45	120.2	81.1	05	170.0	114.6	65	219.7	148.2
26	21.6	14.5	86	71.3	48.1	46	121.0	81.6	06	170.8	115.2	66	220.5	148.7
27	22.4	15.1	87	72.1	48.6	47	121.9	82.2	07	171.6	115.8	67	221.4	149.3
28	23.2	15.7	88	73.0	49.2	43	122.7	82.8	08	172.4	116.3	68	222.2	149.9
29	24.0	16.2	89	73.8	49.8	49	123.5	83.3	09	173.3	116.9	69	223.0	150.4
30	24.9	16.8	90	74.6	50.3	50	124.4	83.9	10	174.1	117.4	70	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	52	126.0	85.0	12	175.8	118.5	72	225.5	152.1
33	27.4	18.5	93	77.1	52.0	53	126.8	85.6	13	176.6	119.1	73	226.3	152.7
34	28.2	19.0	94	77.9	52.6	54	127.7	86.1	14	177.4	119.7	74	227.2	153.2
35	29.0	19.6	95	78.8	53.1	55	128.5	86.7	15	178.2	120.2	75	228.0	153.8
36	29.8	20.1	96	79.6	53.7	56	129.3	87.2	16	179.1	120.8	76	228.8	154.3
37	30.7	20.7	97	80.4	54.2	57	130.2	87.8	17	179.9	121.3	77	229.6	154.9
38	31.5	21.2	98	81.2	54.8	58	131.0	88.4	18	180.7	121.9	78	230.5	155.5
39	32.3	21.8	99	82.1	55.4	59	131.8	88.9	19	181.6	122.5	79	231.3	156.0
40	33.2	22.4	100	82.9	55.9	60	132.6	89.5	20	182.4	123.0	80	232.1	156.6
41	34.0	22.9	101	83.7	56.5	161	133.5	90.0	221	183.2	123.6	281	233.0	157.1
42	34.8	23.5	02	84.6	57.0	62	134.3	90.6	22	184.0	124.1	82	233.8	157.7
43	35.6	24.0	03	85.4	57.6	63	135.1	91.1	23	184.9	124.7	83	234.6	158.3
44	36.5	24.6	04	86.2	58.2	64	136.0	91.7	24	185.7	125.3	84	235.4	158.8
45	37.3	25.2	05	87.0	58.7	65	136.8	92.3	25	186.5	125.8	85	236.3	159.4
46	38.1	25.7	06	87.9	59.3	66	137.6	92.8	26	187.4	126.4	86	237.1	159.9
47	39.0	26.3	07	88.7	59.8	67	138.4	93.4	27	188.2	126.9	87	237.9	160.5
48	39.8	26.8	08	89.5	60.4	68	139.3	93.9	28	189.0	127.5	88	238.8	161.0
49	40.6	27.4	09	90.4	61.0	69	140.1	94.5	29	189.8	128.1	89	239.6	161.6
50	41.5	28.0	10	91.2	61.5	70	140.9	95.1	30	190.7	128.6	90	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	12	92.9	62.6	72	142.6	96.2	32	192.3	129.7	92	242.1	163.3
53	43.9	29.6	13	93.7	63.2	73	143.4	96.7	33	193.2	130.3	93	242.9	163.8
54	44.8	30.2	14	94.5	63.7	74	144.3	97.3	34	194.0	130.9	94	243.7	164.4
55	45.6	30.8	15	95.3	64.3	75	145.1	97.9	35	194.8	131.4	95	244.6	165.0
56	46.4	31.3	16	96.2	64.9	76	145.9	98.4	36	195.7	132.0	96	245.4	165.5
57	47.3	31.9	17	97.0	65.4	77	146.7	99.0	37	196.5	132.5	97	246.2	166.1
58	48.1	32.4	18	97.8	66.0	78	147.6	99.5	38	197.3	133.1	98	247.1	166.6
59	48.9	33.0	19	98.7	66.5	79	148.4	100.1	39	198.1	133.6	99	247.9	167.2
60	49.7	33.6	20	99.5	67.1	80	149.2	100.7	40	199.0	134.2	300	248.7	167.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 56 Degrees.

TABLE II.

Difference of Latitude and Departure for 35 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.0	35.0	121	99.1	69.4	181	148.3	103.8	241	197.4	138.2
2	01.6	01.1	62	50.8	35.6	22	99.9	70.0	82	149.1	104.4	42	198.2	138.8
3	02.5	01.7	63	51.6	36.1	23	100.8	70.5	83	149.9	105.0	43	199.1	139.4
4	03.3	02.3	64	52.4	36.7	24	101.6	71.1	84	150.7	105.5	44	199.9	140.0
5	04.1	02.9	65	53.2	37.3	25	102.4	71.7	85	151.5	106.1	45	200.7	140.5
6	04.9	03.4	66	54.1	37.9	26	103.2	72.3	86	152.4	106.7	46	201.5	141.1
7	05.7	04.0	67	54.9	38.4	27	104.0	72.8	87	153.2	107.3	47	202.3	141.7
8	06.6	04.6	68	55.7	39.0	28	104.9	73.4	88	154.0	107.8	48	203.1	142.2
9	07.4	05.2	69	56.5	39.6	29	105.7	74.0	89	154.8	108.4	49	204.0	142.8
10	08.2	05.7	70	57.3	40.2	30	106.5	74.6	90	155.6	109.0	50	204.8	143.4
11	09.0	06.3	71	58.2	40.7	131	107.3	75.1	191	156.5	109.6	251	205.6	144.0
12	09.8	06.9	72	59.0	41.3	32	108.1	75.7	92	157.3	110.1	52	206.4	144.5
13	10.6	07.5	73	59.8	41.9	33	108.9	76.3	93	158.1	110.7	53	207.2	145.1
14	11.5	08.0	74	60.6	42.4	34	109.8	76.9	94	158.9	111.3	54	208.1	145.7
15	12.3	08.6	75	61.4	43.0	35	110.6	77.4	95	159.7	111.8	55	208.9	146.3
16	13.1	09.2	76	62.3	43.6	36	111.4	78.0	96	160.6	112.4	56	209.7	146.8
17	13.9	09.8	77	63.1	44.2	37	112.2	78.6	97	161.4	113.0	57	210.5	147.4
18	14.7	10.3	78	63.9	44.7	38	113.0	79.2	98	162.2	113.6	58	211.3	148.0
19	15.6	10.9	79	64.7	45.3	39	113.9	79.7	99	163.0	114.1	59	212.2	148.6
20	16.4	11.5	80	65.5	45.9	40	114.7	80.3	200	163.8	114.7	60	213.0	149.1
21	17.2	12.0	81	66.4	46.5	141	115.5	80.9	201	164.6	115.3	261	213.8	149.7
22	18.0	12.6	82	67.2	47.0	42	116.3	81.4	02	165.5	115.9	62	214.6	150.3
23	18.8	13.2	83	68.0	47.6	43	117.1	82.0	03	166.3	116.4	63	215.4	150.9
24	19.7	13.8	84	68.8	48.2	44	118.0	82.6	04	167.1	117.0	64	216.3	151.4
25	20.5	14.3	85	69.6	48.8	45	118.8	83.2	05	167.9	117.6	65	217.1	152.0
26	21.3	14.9	86	70.4	49.3	46	119.6	83.7	06	168.7	118.2	66	217.9	152.6
27	22.1	15.5	87	71.3	49.9	47	120.4	84.3	07	169.6	118.7	67	218.7	153.1
28	22.9	16.1	88	72.1	50.5	48	121.2	84.9	08	170.4	119.3	68	219.5	153.7
29	23.8	16.6	89	72.9	51.0	49	122.1	85.5	09	171.2	119.9	69	220.4	154.3
30	24.6	17.2	90	73.7	51.6	50	122.9	86.0	10	172.0	120.5	70	221.2	154.9
31	25.4	17.8	91	74.5	52.2	151	123.7	86.6	211	172.8	121.0	271	222.0	155.4
32	26.2	18.4	92	75.4	52.8	52	124.5	87.2	12	173.7	121.6	72	222.8	156.0
33	27.0	18.9	93	76.2	53.3	53	125.3	87.8	13	174.5	122.2	73	223.6	156.6
34	27.9	19.5	94	77.0	53.9	54	126.1	88.3	14	175.3	122.7	74	224.4	157.2
35	28.7	20.1	95	77.8	54.5	55	127.0	88.9	15	176.1	123.3	75	225.3	157.7
36	29.5	20.6	96	78.6	55.1	56	127.8	89.5	16	176.9	123.9	76	226.1	158.3
37	30.3	21.2	97	79.5	55.6	57	128.6	90.1	17	177.8	124.5	77	226.9	158.9
38	31.1	21.8	98	80.3	56.2	58	129.4	90.6	18	178.6	125.0	78	227.7	159.5
39	31.9	22.4	99	81.1	56.8	59	130.2	91.2	19	179.4	125.6	79	228.5	160.0
40	32.8	22.9	100	81.9	57.4	60	131.1	91.8	20	180.2	126.2	80	229.4	160.6
41	33.6	23.5	101	82.7	57.9	161	131.9	92.3	221	181.0	126.8	281	230.2	161.2
42	34.4	24.1	02	83.6	58.5	62	132.7	92.9	22	181.9	127.3	82	231.0	161.7
43	35.2	24.7	03	84.4	59.1	63	133.5	93.5	23	182.7	127.9	83	231.8	162.3
44	36.0	25.2	04	85.2	59.7	64	134.3	94.1	24	183.5	128.5	84	232.6	162.9
45	36.9	25.8	05	86.0	60.2	65	135.2	94.6	25	184.3	129.1	85	233.5	163.5
46	37.7	26.4	06	86.8	60.8	66	136.0	95.2	26	185.1	129.6	86	234.3	164.0
47	38.5	27.0	07	87.6	61.4	67	136.8	95.8	27	185.9	130.2	87	235.1	164.6
48	39.3	27.5	08	88.5	61.9	68	137.6	96.4	28	186.8	130.8	88	235.9	165.2
49	40.1	28.1	09	89.3	62.5	69	138.4	96.9	29	187.6	131.3	89	236.7	165.8
50	41.0	28.7	10	90.1	63.1	70	139.3	97.5	30	188.4	131.9	90	237.6	166.3
51	41.8	29.3	111	90.9	63.7	171	140.1	98.1	231	189.2	132.5	291	238.4	166.9
52	42.6	29.8	12	91.7	64.2	72	140.9	98.7	32	190.0	133.1	92	239.2	167.5
53	43.4	30.4	13	92.6	64.8	73	141.7	99.2	33	190.9	133.6	93	240.0	168.1
54	44.2	31.0	14	93.4	65.4	74	142.5	99.8	34	191.7	134.2	94	240.8	168.6
55	45.1	31.5	15	94.2	66.0	75	143.4	100.4	35	192.5	134.8	95	241.6	169.2
56	45.9	32.1	16	95.0	66.5	76	144.2	100.9	36	193.3	135.4	96	242.5	169.8
57	46.7	32.7	17	95.8	67.1	77	145.0	101.5	37	194.1	135.9	97	243.3	170.4
58	47.5	33.3	18	96.7	67.7	78	145.8	102.1	38	195.0	136.5	98	244.1	170.9
59	48.3	33.8	19	97.5	68.3	79	146.6	102.7	39	195.8	137.1	99	244.9	171.5
60	49.1	34.4	20	98.3	68.8	80	147.4	103.2	40	196.6	137.7	300	245.7	172.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 55 Degrees.

TABLE II.

Difference of Latitude and Departure for 36 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	49.4	35.9	121	97.9	71.1	181	146.4	106.4	241	195.0	141.7
2	01.6	01.2	62	50.2	36.4	22	98.7	71.7	82	147.2	107.0	42	195.8	142.2
3	02.4	01.8	63	51.0	37.0	23	99.5	72.3	83	148.1	107.6	43	196.6	142.8
4	03.2	02.4	64	51.8	37.6	24	100.3	72.9	84	148.9	108.2	44	197.4	143.4
5	04.0	02.9	65	52.6	38.2	25	101.1	73.5	85	149.7	108.7	45	198.2	144.0
6	04.9	03.5	66	53.4	38.8	26	101.9	74.1	86	150.5	109.3	46	199.0	144.6
7	05.7	04.1	67	54.2	39.4	27	102.7	74.6	87	151.3	109.9	47	199.8	145.2
8	06.5	04.7	68	55.0	40.0	28	103.6	75.2	88	152.1	110.5	48	200.6	145.8
9	07.3	05.3	69	55.8	40.6	29	104.4	75.8	89	152.9	111.1	49	201.4	146.4
10	08.1	05.9	70	56.6	41.1	30	105.2	76.4	90	153.7	111.7	50	202.3	146.9
11	08.9	06.5	71	57.4	41.7	131	106.0	77.0	191	154.5	112.3	251	203.1	147.5
12	09.7	07.1	72	58.2	42.3	32	106.8	77.6	92	155.3	112.9	52	203.9	148.1
13	10.5	07.6	73	59.1	42.9	33	107.6	78.2	93	156.1	113.4	53	204.7	148.7
14	11.3	08.2	74	59.9	43.5	34	108.4	78.8	94	156.9	114.0	54	205.5	149.3
15	12.1	08.8	75	60.7	44.1	35	109.2	79.4	95	157.8	114.6	55	206.3	149.9
16	12.9	09.4	76	61.5	44.7	36	110.0	79.9	96	158.6	115.2	56	207.1	150.5
17	13.8	10.0	77	62.3	45.3	37	110.8	80.5	97	159.4	115.8	57	207.9	151.1
18	14.6	10.6	78	63.1	45.8	38	111.6	81.1	98	160.2	116.4	58	208.7	151.6
19	15.4	11.2	79	63.9	46.4	39	112.5	81.7	99	161.0	117.0	59	209.5	152.2
20	16.2	11.8	80	64.7	47.0	40	113.3	82.3	200	161.8	117.6	60	210.3	152.8
21	17.0	12.3	81	65.5	47.6	141	114.1	82.9	201	162.6	118.1	261	211.2	153.4
22	17.8	12.9	82	66.3	48.2	42	114.9	83.5	02	163.4	118.7	62	212.0	154.0
23	18.6	13.5	83	67.1	48.8	43	115.7	84.1	03	164.2	119.3	63	212.8	154.6
24	19.4	14.1	84	68.0	49.4	44	116.5	84.6	04	165.0	119.9	64	213.6	155.2
25	20.2	14.7	85	68.8	50.0	45	117.3	85.2	05	165.8	120.5	65	214.4	155.8
26	21.0	15.3	86	69.6	50.5	46	118.1	85.8	06	166.7	121.1	66	215.2	156.4
27	21.8	15.9	87	70.4	51.1	47	118.9	86.4	07	167.5	121.7	67	216.0	156.9
28	22.7	16.5	88	71.2	51.7	48	119.7	87.0	08	168.3	122.3	68	216.8	157.5
29	23.5	17.0	89	72.0	52.3	49	120.5	87.6	09	169.1	122.8	69	217.6	158.1
30	24.3	17.6	90	72.8	52.9	50	121.4	88.2	10	169.9	123.4	70	218.4	158.7
31	25.1	18.2	91	73.6	53.5	151	122.2	88.8	211	170.7	124.0	271	219.2	159.3
32	25.9	18.8	92	74.4	54.1	52	123.0	89.3	12	171.5	124.6	72	220.1	159.9
33	26.7	19.4	93	75.2	54.7	53	123.8	89.9	13	172.3	125.2	73	220.9	160.5
34	27.5	20.0	94	76.0	55.3	54	124.6	90.5	14	173.1	125.8	74	221.7	161.1
35	28.3	20.6	95	76.9	55.8	55	125.4	91.1	15	173.9	126.4	75	222.5	161.6
36	29.1	21.2	96	77.7	56.4	56	126.2	91.7	16	174.7	127.0	76	223.3	162.2
37	29.9	21.7	97	78.5	57.0	57	127.0	92.3	17	175.6	127.5	77	224.1	162.8
38	30.7	22.3	98	79.3	57.6	58	127.8	92.9	18	176.4	128.1	78	224.9	163.4
39	31.6	22.9	99	80.1	58.2	59	128.6	93.5	19	177.2	128.7	79	225.7	164.0
40	32.4	23.5	100	80.9	58.8	60	129.4	94.0	20	178.0	129.3	80	226.5	164.6
41	33.2	24.1	101	81.7	59.4	161	130.3	94.6	221	178.8	129.9	281	227.3	165.2
42	34.0	24.7	02	82.5	60.0	62	131.1	95.2	22	179.6	130.5	82	228.1	165.8
43	34.8	25.3	03	83.3	60.5	63	131.9	95.8	23	180.4	131.1	83	229.0	166.3
44	35.6	25.9	04	84.1	61.1	64	132.7	96.4	24	181.2	131.7	84	229.8	166.9
45	36.4	26.5	05	84.9	61.7	65	133.5	97.0	25	182.0	132.3	85	230.6	167.5
46	37.2	27.0	06	85.8	62.3	66	134.3	97.6	26	182.8	132.8	86	231.4	168.1
47	38.0	27.6	07	86.6	62.9	67	135.1	98.2	27	183.6	133.4	87	232.2	168.7
48	38.8	28.2	08	87.4	63.5	68	135.9	98.7	28	184.5	134.0	88	233.0	169.3
49	39.6	28.8	09	88.2	64.1	69	136.7	99.3	29	185.3	134.6	89	233.8	169.9
50	40.5	29.4	10	89.0	64.7	70	137.5	99.9	30	186.1	135.2	90	234.6	170.5
51	41.3	30.0	111	89.8	65.2	171	138.3	100.5	231	186.9	135.8	291	235.4	171.0
52	42.1	30.6	12	90.6	65.8	72	139.2	101.1	32	187.7	136.4	92	236.2	171.6
53	42.9	31.2	13	91.4	66.4	73	140.0	101.7	33	188.5	137.0	93	237.0	172.2
54	43.7	31.7	14	92.2	67.0	74	140.8	102.3	34	189.3	137.5	94	237.9	172.8
55	44.5	32.3	15	93.0	67.6	75	141.6	102.9	35	190.1	138.1	95	238.7	173.4
56	45.3	32.9	16	93.8	68.2	76	142.4	103.5	36	190.9	138.7	96	239.5	174.0
57	46.1	33.5	17	94.7	68.8	77	143.2	104.0	37	191.7	139.3	97	240.3	174.6
58	46.9	34.1	18	95.5	69.4	78	144.0	104.6	38	192.5	139.9	98	241.1	175.2
59	47.7	34.7	19	96.3	69.9	79	144.8	105.2	39	193.4	140.5	99	241.9	175.7
60	48.5	35.3	20	97.1	70.5	80	145.6	105.8	40	194.2	141.1	300	242.7	176.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 54 Degrees.

Difference of Latitude and Departure for 37 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	48.7	36.7	121	96.6	72.8	181	144.6	108.9	241	192.5	145.0
2	01.6	01.2	62	49.5	37.3	22	97.4	73.4	82	145.4	109.5	42	193.3	145.6
3	02.4	01.8	63	50.3	37.9	23	98.2	74.0	83	146.2	110.1	43	194.1	146.2
4	03.2	02.4	64	51.1	38.5	24	99.0	74.6	84	146.9	110.7	44	194.9	146.8
5	04.0	03.0	65	51.9	39.1	25	99.8	75.2	85	147.7	111.3	45	195.7	147.4
6	04.8	03.6	66	52.7	39.7	26	100.6	75.8	86	148.5	111.9	46	196.5	148.0
7	05.6	04.2	67	53.5	40.3	27	101.4	76.4	87	149.3	112.5	47	197.3	148.6
8	06.4	04.8	68	54.3	40.9	28	102.2	77.0	88	150.1	113.1	48	198.1	149.3
9	07.2	05.4	69	55.1	41.5	29	103.0	77.6	89	150.9	113.7	49	198.9	149.9
10	08.0	06.0	70	55.9	42.1	30	103.8	78.2	90	151.7	114.3	50	199.7	150.5
11	08.8	06.6	71	56.7	42.7	131	104.6	78.8	191	152.5	114.9	251	200.5	151.1
12	09.6	07.2	72	57.5	43.3	32	105.4	79.4	92	153.3	115.5	52	201.3	151.7
13	10.4	07.8	73	58.3	43.9	33	106.2	80.0	93	154.1	116.2	53	202.1	152.3
14	11.2	08.4	74	59.1	44.5	34	107.0	80.6	94	154.9	116.8	54	202.9	152.9
15	12.0	09.0	75	59.9	45.1	35	107.8	81.2	95	155.7	117.4	55	203.7	153.5
16	12.8	09.6	76	60.7	45.7	36	108.6	81.8	96	156.5	118.0	56	204.5	154.1
17	13.6	10.2	77	61.5	46.3	37	109.4	82.4	97	157.3	118.6	57	205.2	154.7
18	14.4	10.8	78	62.3	46.9	38	110.2	83.1	98	158.1	119.2	58	206.0	155.3
19	15.2	11.4	79	63.1	47.5	39	111.0	83.7	99	158.9	119.8	59	206.8	155.9
20	16.0	12.0	80	63.9	48.1	40	111.8	84.3	200	159.7	120.4	60	207.6	156.5
21	16.8	12.6	81	64.7	48.7	141	112.6	84.9	201	160.5	121.0	261	208.4	157.1
22	17.6	13.2	82	65.5	49.3	42	113.4	85.5	02	161.3	121.6	62	209.2	157.7
23	18.4	13.8	83	66.3	50.0	43	114.2	86.1	03	162.1	122.2	63	210.0	158.3
24	19.2	14.4	84	67.1	50.6	44	115.0	86.7	04	162.9	122.8	64	210.8	158.9
25	20.0	15.0	85	67.9	51.2	45	115.8	87.3	05	163.7	123.4	65	211.6	159.5
26	20.8	15.6	86	68.7	51.8	46	116.6	87.9	06	164.5	124.0	66	212.4	160.1
27	21.6	16.2	87	69.5	52.4	47	117.4	88.5	07	165.3	124.6	67	213.2	160.7
28	22.4	16.9	88	70.3	53.0	48	118.2	89.1	08	166.1	125.2	68	214.0	161.3
29	23.2	17.5	89	71.1	53.6	49	119.0	89.7	09	166.9	125.8	69	214.8	161.9
30	24.0	18.1	90	71.9	54.2	50	119.8	90.3	10	167.7	126.4	70	215.6	162.5
31	24.8	18.7	91	72.7	54.8	151	120.6	90.9	211	168.5	127.0	271	216.4	163.1
32	25.6	19.3	92	73.5	55.4	52	121.4	91.5	12	169.3	127.6	72	217.2	163.7
33	26.4	19.9	93	74.3	56.0	53	122.2	92.1	13	170.1	128.2	73	218.0	164.3
34	27.2	20.5	94	75.1	56.6	54	123.0	92.7	14	170.9	128.8	74	218.8	164.9
35	28.0	21.1	95	75.9	57.2	55	123.8	93.3	15	171.7	129.4	75	219.6	165.5
36	28.8	21.7	96	76.7	57.8	56	124.6	93.9	16	172.5	130.0	76	220.4	166.1
37	29.5	22.3	97	77.5	58.4	57	125.4	94.5	17	173.3	130.6	77	221.2	166.7
38	30.3	22.9	98	78.3	59.0	58	126.2	95.1	18	174.1	131.2	78	222.0	167.3
39	31.1	23.5	99	79.1	59.6	59	127.0	95.7	19	174.9	131.8	79	222.8	167.9
40	31.9	24.1	100	79.9	60.2	60	127.8	96.3	20	175.7	132.4	80	223.6	168.5
41	32.7	24.7	101	80.7	60.8	161	128.6	96.9	221	176.5	133.0	281	224.4	169.1
42	33.5	25.3	02	81.5	61.4	62	129.4	97.5	22	177.3	133.6	82	225.2	169.7
43	34.3	25.9	03	82.3	62.0	63	130.2	98.1	23	178.1	134.2	83	226.0	170.3
44	35.1	26.5	04	83.1	62.6	64	131.0	98.7	24	178.9	134.8	84	226.8	170.9
45	35.9	27.1	05	83.9	63.2	65	131.8	99.3	25	179.7	135.4	85	227.6	171.5
46	36.7	27.7	06	84.7	63.8	66	132.6	99.9	26	180.5	136.0	86	228.4	172.1
47	37.5	28.3	07	85.5	64.4	67	133.4	100.5	27	181.3	136.6	87	229.2	172.7
48	38.3	28.9	08	86.3	65.0	68	134.2	101.1	28	182.1	137.2	88	230.0	173.3
49	39.1	29.5	09	87.1	65.6	69	135.0	101.7	29	182.9	137.8	89	230.8	173.9
50	39.9	30.1	10	87.8	66.2	70	135.8	102.3	30	183.7	138.4	90	231.6	174.5
51	40.7	30.7	111	88.6	66.8	171	136.6	102.9	231	184.5	139.0	291	232.4	175.1
52	41.5	31.3	12	89.4	67.4	72	137.4	103.5	32	185.3	139.6	92	233.2	175.7
53	42.3	31.9	13	90.2	68.0	73	138.2	104.1	33	186.1	140.2	93	234.0	176.3
54	43.1	32.5	14	91.0	68.6	74	139.0	104.7	34	186.9	140.8	94	234.8	176.9
55	43.9	33.1	15	91.8	69.2	75	139.8	105.3	35	187.7	141.4	95	235.6	177.5
56	44.7	33.7	16	92.6	69.8	76	140.6	105.9	36	188.5	142.0	96	236.4	178.1
57	45.5	34.3	17	93.4	70.4	77	141.4	106.5	37	189.3	142.6	97	237.2	178.7
58	46.3	34.9	18	94.2	71.0	78	142.2	107.1	38	190.1	143.2	98	238.0	179.3
59	47.1	35.5	19	95.0	71.6	79	143.0	107.7	39	190.9	143.8	99	238.8	179.9
60	47.9	36.1	20	95.8	72.2	80	143.8	108.3	40	191.7	144.4	300	239.6	180.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

Difference of Latitude and Departure for 38 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	48.1	37.6	121	95.3	74.5	181	142.6	111.4	241	189.9	148.4
2	01.6	01.2	62	48.9	38.2	22	96.1	75.1	82	143.4	112.1	42	190.7	149.0
3	02.4	01.8	63	49.6	38.8	23	96.9	75.7	83	144.2	112.7	43	191.5	149.6
4	03.2	02.5	64	50.4	39.4	24	97.7	76.3	84	145.0	113.3	44	192.3	150.2
5	03.9	03.1	65	51.2	40.0	25	98.5	77.0	85	145.8	113.9	45	193.1	150.8
6	04.7	03.7	66	52.0	40.6	26	99.3	77.6	86	146.6	114.5	46	193.9	151.5
7	05.5	04.3	67	52.8	41.2	27	100.1	78.2	87	147.4	115.1	47	194.6	152.1
8	06.3	04.9	68	53.6	41.9	28	100.9	78.8	88	148.1	115.7	48	195.4	152.7
9	07.1	05.5	69	54.4	42.5	29	101.7	79.4	89	148.9	116.4	49	196.2	153.3
10	07.9	06.2	70	55.2	43.1	30	102.4	80.0	90	149.7	117.0	50	197.0	153.9
11	08.7	06.8	71	55.9	43.7	131	103.2	80.7	191	150.5	117.6	251	197.8	154.5
12	09.5	07.4	72	56.7	44.3	32	104.0	81.3	92	151.3	118.2	52	198.6	155.1
13	10.2	08.0	73	57.5	44.9	33	104.8	81.9	93	152.1	118.8	53	199.4	155.8
14	11.0	08.6	74	58.3	45.6	34	105.6	82.5	94	152.9	119.4	54	200.2	156.4
15	11.8	09.2	75	59.1	46.2	35	106.4	83.1	95	153.7	120.1	55	200.9	157.0
16	12.6	09.9	76	59.9	46.8	36	107.2	83.7	96	154.5	120.7	56	201.7	157.6
17	13.4	10.5	77	60.7	47.4	37	108.0	84.3	97	155.2	121.3	57	202.5	158.2
18	14.2	11.1	78	61.5	48.0	38	108.7	85.0	98	156.0	121.9	58	203.3	158.8
19	15.0	11.7	79	62.3	48.6	39	109.5	85.6	99	156.8	122.5	59	204.1	159.5
20	15.8	12.3	80	63.0	49.3	40	110.3	86.2	200	157.6	123.1	60	204.9	160.1
21	16.5	12.9	81	63.8	49.9	141	111.1	86.8	201	158.4	123.7	261	205.7	160.7
22	17.3	13.5	82	64.6	50.5	42	111.9	87.4	02	159.2	124.4	62	206.5	161.3
23	18.1	14.2	83	65.4	51.1	43	112.7	88.0	03	160.0	125.0	63	207.2	161.9
24	18.9	14.8	84	66.2	51.7	44	113.5	88.7	04	160.8	125.6	64	208.0	162.5
25	19.7	15.4	85	67.0	52.3	45	114.3	89.3	05	161.5	126.2	65	208.8	163.2
26	20.5	16.0	86	67.8	52.9	46	115.0	89.9	06	162.3	126.8	66	209.6	163.8
27	21.3	16.6	87	68.6	53.6	47	115.8	90.5	07	163.1	127.4	67	210.4	164.4
28	22.1	17.2	88	69.3	54.2	48	116.6	91.1	08	163.9	128.1	68	211.2	165.0
29	22.9	17.9	89	70.1	54.8	49	117.4	91.7	09	164.7	128.7	69	212.0	165.6
30	23.6	18.5	90	70.9	55.4	50	118.2	92.3	10	165.5	129.3	70	212.8	166.2
31	24.4	19.1	91	71.7	56.0	151	119.0	93.0	211	166.3	129.9	271	213.6	166.8
32	25.2	19.7	92	72.5	56.6	52	119.8	93.6	12	167.1	130.5	72	214.3	167.5
33	26.0	20.3	93	73.3	57.3	53	120.6	94.2	13	167.8	131.1	73	215.1	168.1
34	26.8	20.9	94	74.1	57.9	54	121.4	94.8	14	168.6	131.8	74	215.9	168.7
35	27.6	21.5	95	74.9	58.5	55	122.1	95.4	15	169.4	132.4	75	216.7	169.3
36	28.4	22.2	96	75.6	59.1	56	122.9	96.0	16	170.2	133.0	76	217.5	169.9
37	29.2	22.8	97	76.4	59.7	57	123.7	96.7	17	171.0	133.6	77	218.3	170.5
38	29.9	23.4	98	77.2	60.3	58	124.5	97.3	18	171.8	134.2	78	219.1	171.2
39	30.7	24.0	99	78.0	61.0	59	125.3	97.9	19	172.6	134.8	79	219.9	171.8
40	31.5	24.6	100	78.8	61.6	60	126.1	98.5	20	173.4	135.4	80	220.6	172.4
41	32.3	25.2	101	79.6	62.2	161	126.9	99.1	221	174.2	136.1	281	221.4	173.0
42	33.1	25.9	02	80.4	62.8	62	127.7	99.7	22	174.9	136.7	82	222.2	173.6
43	33.9	26.5	03	81.2	63.4	63	128.4	100.4	23	175.7	137.3	83	223.0	174.2
44	34.7	27.1	04	82.0	64.0	64	129.2	101.0	24	176.5	137.9	84	223.8	174.8
45	35.5	27.7	05	82.7	64.6	65	130.0	101.6	25	177.3	138.5	85	224.6	175.5
46	36.2	28.3	06	83.5	65.3	66	130.8	102.2	26	178.1	139.1	86	225.4	176.1
47	37.0	28.9	07	84.3	65.9	67	131.6	102.8	27	178.9	139.8	87	226.2	176.7
48	37.8	29.6	08	85.1	66.5	68	132.4	103.4	28	179.7	140.4	88	226.9	177.3
49	38.6	30.2	09	85.9	67.1	69	133.2	104.0	29	180.5	141.0	89	227.7	177.9
50	39.4	30.8	10	86.7	67.7	70	134.0	104.7	30	181.2	141.6	90	228.5	178.5
51	40.2	31.4	111	87.5	68.3	171	134.7	105.3	231	182.0	142.2	291	229.3	179.2
52	41.0	32.0	12	88.3	69.0	72	135.5	105.9	32	182.8	142.8	92	230.1	179.8
53	41.8	32.6	13	89.0	69.6	73	136.3	106.5	33	183.6	143.4	93	230.9	180.4
54	42.6	33.2	14	89.8	70.2	74	137.1	107.1	34	184.4	144.1	94	231.7	181.0
55	43.3	33.9	15	90.6	70.8	75	137.9	107.7	35	185.2	144.7	95	232.5	181.6
56	44.1	34.5	16	91.4	71.4	76	138.7	108.4	36	186.0	145.3	96	233.3	182.2
57	44.9	35.1	17	92.2	72.0	77	139.5	109.0	37	186.8	145.9	97	234.0	182.9
58	45.7	35.7	18	93.0	72.6	78	140.3	109.6	38	187.5	146.5	98	234.8	183.5
59	46.5	36.3	19	93.8	73.3	79	141.1	110.2	39	188.3	147.1	99	235.6	184.1
60	47.3	36.9	20	94.6	73.9	80	141.8	110.8	40	189.1	147.8	300	236.4	184.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 52 Degrees.

TABLE II.

Difference of Latitude and Departure for 39 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	01.6	01.3	62	48.2	39.0	22	94.8	76.8	82	141.4	114.5	42	188.1	152.3
3	02.3	01.9	63	49.0	39.6	23	95.6	77.4	83	142.2	115.2	43	188.8	152.9
4	03.1	02.5	64	49.7	40.3	24	96.4	78.0	84	143.0	115.8	44	189.6	153.6
5	03.9	03.1	65	50.5	40.9	25	97.1	78.7	85	143.8	116.4	45	190.4	154.2
6	04.7	03.8	66	51.3	41.5	26	97.9	79.3	86	144.5	117.1	46	191.2	154.8
7	05.4	04.4	67	52.1	42.2	27	98.7	79.9	87	145.3	117.7	47	192.0	155.4
8	06.2	05.0	68	52.8	42.8	28	99.5	80.6	88	146.1	118.3	48	192.7	156.1
9	07.0	05.7	69	53.6	43.4	29	100.3	81.2	89	146.9	118.9	49	193.5	156.7
10	07.8	06.3	70	54.4	44.1	30	101.0	81.8	90	147.7	119.6	50	194.3	157.3
11	08.5	06.9	71	55.2	44.7	131	101.8	82.4	191	148.4	120.2	251	195.1	158.0
12	09.3	07.6	72	56.0	45.3	32	102.6	83.1	92	149.2	120.8	52	195.8	158.6
13	10.1	08.2	73	56.7	45.9	33	103.4	83.7	93	150.0	121.5	53	196.6	159.2
14	10.9	08.8	74	57.5	46.6	34	104.1	84.3	94	150.8	122.1	54	197.4	159.8
15	11.7	09.4	75	58.3	47.2	35	104.9	85.0	95	151.5	122.7	55	198.2	160.5
16	12.4	10.1	76	59.1	47.8	36	105.7	85.6	96	152.3	123.3	56	198.9	161.1
17	13.2	10.7	77	59.8	48.5	37	106.5	86.2	97	153.1	124.0	57	199.7	161.7
18	14.0	11.3	78	60.6	49.1	38	107.2	86.8	98	153.9	124.6	58	200.5	162.4
19	14.8	12.0	79	61.4	49.7	39	108.0	87.5	99	154.7	125.2	59	201.3	163.0
20	15.5	12.6	80	62.2	50.3	40	108.8	88.1	200	155.4	125.9	60	202.1	163.6
21	16.3	13.2	81	62.9	51.0	141	109.6	88.7	201	156.2	126.5	261	202.8	164.3
22	17.1	13.8	82	63.7	51.6	42	110.4	89.4	02	157.0	127.1	62	203.6	164.9
23	17.9	14.5	83	64.5	52.2	43	111.1	90.0	03	157.8	127.8	63	204.4	165.5
24	18.7	15.1	84	65.3	52.9	44	111.9	90.6	04	158.5	128.4	64	205.2	166.1
25	19.4	15.7	85	66.1	53.5	45	112.7	91.3	05	159.3	129.0	65	205.9	166.8
26	20.2	16.4	86	66.8	54.1	46	113.5	91.9	06	160.1	129.6	66	206.7	167.4
27	21.0	17.0	87	67.6	54.8	47	114.2	92.5	07	160.9	130.3	67	207.5	168.0
28	21.8	17.6	88	68.4	55.4	48	115.0	93.1	08	161.6	130.9	68	208.3	168.7
29	22.5	18.3	89	69.2	56.0	49	115.8	93.8	09	162.4	131.5	69	209.1	169.3
30	23.3	18.9	90	69.9	56.6	50	116.6	94.4	10	163.2	132.2	70	209.8	169.9
31	24.1	19.5	91	70.7	57.3	151	117.3	95.0	211	164.0	132.8	271	210.6	170.5
32	24.9	20.1	92	71.5	57.9	52	118.1	95.7	12	164.8	133.4	72	211.4	171.2
33	25.6	20.8	93	72.3	58.5	53	118.9	96.3	13	165.5	134.0	73	212.2	171.8
34	26.4	21.4	94	73.1	59.2	54	119.7	96.9	14	166.3	134.7	74	212.9	172.4
35	27.2	22.0	95	73.8	59.8	55	120.5	97.5	15	167.1	135.3	75	213.7	173.1
36	28.0	22.7	96	74.6	60.4	56	121.2	98.2	16	167.9	135.9	76	214.5	173.7
37	28.8	23.3	97	75.4	61.0	57	122.0	98.8	17	168.6	136.6	77	215.3	174.3
38	29.5	23.9	98	76.2	61.7	58	122.8	99.4	18	169.4	137.2	78	216.0	175.0
39	30.3	24.5	99	76.9	62.3	59	123.6	100.1	19	170.2	137.8	79	216.8	175.6
40	31.1	25.2	100	77.7	62.9	60	124.3	100.7	20	171.0	138.5	80	217.6	176.2
41	31.9	25.8	101	78.5	63.6	161	125.1	101.3	221	171.7	139.1	281	218.4	176.8
42	32.6	26.4	02	79.3	64.2	62	125.9	101.9	22	172.5	139.7	82	219.2	177.5
43	33.4	27.1	03	80.0	64.8	63	126.7	102.6	23	173.3	140.3	83	219.9	178.1
44	34.2	27.7	04	80.8	65.4	64	127.5	103.2	24	174.1	141.0	84	220.7	178.7
45	35.0	28.3	05	81.6	66.1	65	128.2	103.8	25	174.9	141.6	85	221.5	179.4
46	35.7	28.9	06	82.4	66.7	66	129.0	104.5	26	175.6	142.2	86	222.3	180.0
47	36.5	29.6	07	83.2	67.3	67	129.8	105.1	27	176.4	142.9	87	223.0	180.6
48	37.3	30.2	08	83.9	68.0	68	130.6	105.7	28	177.2	143.5	88	223.8	181.2
49	38.1	30.8	09	84.7	68.6	69	131.3	106.4	29	178.0	144.1	89	224.6	181.9
50	38.9	31.5	10	85.5	69.2	70	132.1	107.0	30	178.7	144.7	90	225.4	182.5
51	39.6	32.1	111	86.3	69.9	171	132.9	107.6	231	179.5	145.4	291	226.1	183.1
52	40.4	32.7	12	87.0	70.5	72	133.7	108.2	32	180.3	146.0	92	226.9	183.8
53	41.2	33.4	13	87.8	71.1	73	134.4	108.9	33	181.1	146.6	93	227.7	184.4
54	42.0	34.0	14	88.6	71.7	74	135.2	109.5	34	181.9	147.3	94	228.5	185.0
55	42.7	34.6	15	89.4	72.4	75	136.0	110.1	35	182.6	147.9	95	229.3	185.6
56	43.5	35.2	16	90.1	73.0	76	136.8	110.8	36	183.4	148.5	96	230.0	186.3
57	44.3	35.9	17	90.9	73.6	77	137.6	111.4	37	184.2	149.1	97	230.8	186.9
58	45.1	36.5	18	91.7	74.3	78	138.3	112.0	38	185.0	149.8	98	231.6	187.5
59	45.9	37.1	19	92.5	74.9	79	139.1	112.6	39	185.7	150.4	99	232.4	188.2
60	46.6	37.8	20	93.3	75.5	80	139.9	113.3	40	186.5	151.0	300	233.1	188.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 51 Degrees.

TABLE II.

Difference of Latitude and Departure for 40 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	46.7	39.2	121	92.7	77.8	181	138.7	116.3	241	184.6	154.9
2	01.5	01.3	62	47.5	39.9	22	93.5	78.4	82	139.4	117.0	42	185.4	155.6
3	02.3	01.9	63	48.3	40.5	23	94.2	79.1	83	140.2	117.6	43	186.1	156.2
4	03.1	02.6	64	49.0	41.1	24	95.0	79.7	84	141.0	118.3	44	186.9	156.8
5	03.8	03.2	65	49.8	41.8	25	95.8	80.3	85	141.7	118.9	45	187.7	157.5
6	04.6	03.9	66	50.6	42.4	26	96.5	81.0	86	142.5	119.6	46	188.4	158.1
7	05.4	04.5	67	51.3	43.1	27	97.3	81.6	87	143.3	120.2	47	189.2	158.8
8	06.1	05.1	68	52.1	43.7	28	98.1	82.3	88	144.0	120.8	48	190.0	159.4
9	06.9	05.8	69	52.9	44.4	29	98.8	82.9	89	144.8	121.5	49	190.7	160.1
10	07.7	06.4	70	53.6	45.0	30	99.6	83.6	90	145.5	122.1	50	191.5	160.7
11	08.4	07.1	71	54.4	45.6	131	100.4	84.2	191	146.3	122.8	251	192.3	161.3
12	09.2	07.7	72	55.2	46.3	32	101.1	84.8	92	147.1	123.4	52	193.0	162.0
13	10.0	08.4	73	55.9	46.9	33	101.9	85.5	93	147.8	124.1	53	193.8	162.6
14	10.7	09.0	74	56.7	47.6	34	102.6	86.1	94	148.6	124.7	54	194.6	163.3
15	11.5	09.6	75	57.5	48.2	35	103.4	86.8	95	149.4	125.3	55	195.3	163.9
16	12.3	10.3	76	58.2	48.9	36	104.2	87.4	96	150.1	126.0	56	196.1	164.6
17	13.0	10.9	77	59.0	49.5	37	104.9	88.1	97	150.9	126.6	57	196.9	165.2
18	13.8	11.6	78	59.8	50.1	38	105.7	88.7	98	151.7	127.3	58	197.6	165.8
19	14.6	12.2	79	60.5	50.8	39	106.5	89.3	99	152.4	127.9	59	198.4	166.5
20	15.3	12.9	80	61.3	51.4	40	107.2	90.0	200	153.2	128.6	60	199.2	167.1
21	16.1	13.5	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.9	167.8
22	16.9	14.1	82	62.8	52.7	42	108.8	91.3	02	154.7	129.8	62	200.7	168.4
23	17.6	14.8	83	63.6	53.4	43	109.5	91.9	03	155.5	130.5	63	201.5	169.1
24	18.4	15.4	84	64.3	54.0	44	110.3	92.6	04	156.3	131.1	64	202.2	169.7
25	19.2	16.1	85	65.1	54.6	45	111.1	93.2	05	157.0	131.8	65	203.0	170.3
26	19.9	16.7	86	65.9	55.3	46	111.8	93.8	06	157.8	132.4	66	203.8	171.0
27	20.7	17.4	87	66.6	55.9	47	112.6	94.5	07	158.6	133.1	67	204.5	171.6
28	21.4	18.0	88	67.4	56.6	48	113.4	95.1	08	159.3	133.7	68	205.3	172.3
29	22.2	18.6	89	68.2	57.2	49	114.1	95.8	09	160.1	134.3	69	206.1	172.9
30	23.0	19.3	90	68.9	57.9	50	114.9	96.4	10	160.9	135.0	70	206.8	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.6	135.6	271	207.6	174.2
32	24.5	20.6	92	70.5	59.1	52	116.4	97.7	12	162.4	136.3	72	208.4	174.8
33	25.3	21.2	93	71.2	59.8	53	117.2	98.3	13	163.2	136.9	73	209.1	175.5
34	26.0	21.9	94	72.0	60.4	54	118.0	99.0	14	163.9	137.6	74	209.9	176.1
35	26.8	22.5	95	72.8	61.1	55	118.7	99.6	15	164.7	138.2	75	210.7	176.8
36	27.6	23.1	96	73.5	61.7	56	119.5	100.3	16	165.5	138.8	76	211.4	177.4
37	28.3	23.8	97	74.3	62.4	57	120.3	100.9	17	166.2	139.5	77	212.2	178.1
38	29.1	24.4	98	75.1	63.0	58	121.0	101.6	18	167.0	140.1	78	213.0	178.7
39	29.9	25.1	99	75.8	63.6	59	121.8	102.2	19	167.8	140.8	79	213.7	179.3
40	30.6	25.7	100	76.6	64.3	60	122.6	102.8	20	168.5	141.4	80	214.5	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.3	142.1	281	215.3	180.6
42	32.2	27.0	02	78.1	65.6	62	124.1	104.1	22	170.1	142.7	82	216.0	181.3
43	32.9	27.6	03	78.9	66.2	63	124.9	104.8	23	170.8	143.3	83	216.8	181.9
44	33.7	28.3	04	79.7	66.8	64	125.6	105.4	24	171.6	144.0	84	217.6	182.6
45	34.5	28.9	05	80.4	67.5	65	126.4	106.1	25	172.4	144.6	85	218.3	183.2
46	35.2	29.6	06	81.2	68.1	66	127.2	106.7	26	173.1	145.3	86	219.1	183.8
47	36.0	30.2	07	82.0	68.8	67	127.9	107.3	27	173.9	145.9	87	219.9	184.5
48	36.8	30.9	08	82.7	69.4	68	128.7	108.0	28	174.7	146.6	88	220.6	185.1
49	37.5	31.5	09	83.5	70.1	69	129.5	108.6	29	175.4	147.2	89	221.4	185.8
50	38.3	32.1	10	84.3	70.7	70	130.2	109.3	30	176.2	147.8	90	222.2	186.4
51	39.1	32.8	111	85.0	71.3	171	131.0	109.9	231	177.0	148.5	291	222.9	187.1
52	39.8	33.4	12	85.8	72.0	72	131.8	110.6	32	177.7	149.1	92	223.7	187.7
53	40.6	34.1	13	86.6	72.6	73	132.5	111.2	33	178.5	149.8	93	224.5	188.3
54	41.4	34.7	14	87.3	73.3	74	133.3	111.8	34	179.3	150.4	94	225.2	189.0
55	42.1	35.4	15	88.1	73.9	75	134.1	112.5	35	180.0	151.1	95	226.0	189.6
56	42.9	36.0	16	88.9	74.6	76	134.8	113.1	36	180.8	151.7	96	226.7	190.3
57	43.7	36.6	17	89.6	75.2	77	135.6	113.8	37	181.6	152.3	97	227.5	190.9
58	44.4	37.3	18	90.4	75.8	78	136.4	114.4	38	182.3	153.0	98	228.3	191.6
59	45.2	37.9	19	91.2	76.5	79	137.1	115.1	39	183.1	153.6	99	229.0	192.2
60	46.0	38.6	20	91.9	77.1	80	137.9	115.7	40	183.9	154.3	300	229.8	192.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 50 Degrees.

Difference of Latitude and Departure for 41 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	01.5	01.3	62	46.8	40.7	22	92.1	80.0	82	137.4	119.4	42	182.6	158.8
3	02.3	02.0	63	47.5	41.3	23	92.8	80.7	83	138.1	120.1	43	183.4	159.4
4	03.0	02.6	64	48.3	42.0	24	93.6	81.4	84	138.9	120.7	44	184.1	160.1
5	03.8	03.3	65	49.1	42.6	25	94.3	82.0	85	139.6	121.4	45	184.9	160.7
6	04.5	03.9	66	49.8	43.3	26	95.1	82.7	86	140.4	122.0	46	185.7	161.4
7	05.3	04.6	67	50.6	44.0	27	95.8	83.3	87	141.1	122.7	47	186.4	162.0
8	06.0	05.2	68	51.3	44.6	28	96.6	84.0	88	141.9	123.3	48	187.2	162.7
9	06.8	05.9	69	52.1	45.3	29	97.4	84.6	89	142.6	124.0	49	187.9	163.4
10	07.5	06.6	70	52.8	45.9	30	98.1	85.3	90	143.4	124.7	50	188.7	164.0
11	08.3	07.2	71	53.6	46.6	131	98.9	85.9	191	144.1	125.3	251	189.4	164.7
12	09.1	07.9	72	54.3	47.2	32	99.6	86.6	92	144.9	126.0	52	190.2	165.3
13	09.8	08.5	73	55.1	47.9	33	100.4	87.3	93	145.7	126.6	53	190.9	166.0
14	10.6	09.2	74	55.8	48.5	34	101.1	87.9	94	146.4	127.3	54	191.7	166.6
15	11.3	09.8	75	56.6	49.2	35	101.9	88.6	95	147.2	127.9	55	192.5	167.3
16	12.1	10.5	76	57.4	49.9	36	102.6	89.2	96	147.9	128.6	56	193.2	168.0
17	12.8	11.2	77	58.1	50.5	37	103.4	89.9	97	148.7	129.2	57	194.0	168.6
18	13.6	11.8	78	58.9	51.2	38	104.1	90.5	98	149.4	129.9	58	194.7	169.3
19	14.3	12.5	79	59.6	51.8	39	104.9	91.2	99	150.2	130.6	59	195.5	169.9
20	15.1	13.1	80	60.4	52.5	40	105.7	91.8	200	150.9	131.2	60	196.2	170.6
21	15.8	13.8	81	61.1	53.1	141	106.4	92.5	201	151.7	131.9	261	197.0	171.2
22	16.6	14.4	82	61.9	53.8	42	107.2	93.2	02	152.5	132.5	62	197.7	171.9
23	17.4	15.1	83	62.6	54.5	43	107.9	93.8	03	153.2	133.2	63	198.5	172.5
24	18.1	15.7	84	63.4	55.1	44	108.7	94.5	04	154.0	133.8	64	199.2	173.2
25	18.9	16.4	85	64.2	55.8	45	109.4	95.1	05	154.7	134.5	65	200.0	173.9
26	19.6	17.1	86	64.9	56.4	46	110.2	95.8	06	155.5	135.1	66	200.8	174.5
27	20.4	17.7	87	65.7	57.1	47	110.9	96.4	07	156.2	135.8	67	201.5	175.2
28	21.1	18.4	88	66.4	57.7	48	111.7	97.1	08	157.0	136.5	68	202.3	175.8
29	21.9	19.0	89	67.2	58.4	49	112.5	97.8	09	157.7	137.1	69	203.0	176.5
30	22.6	19.7	90	67.9	59.0	50	113.2	98.4	10	158.5	137.8	70	203.8	177.1
31	23.4	20.3	91	68.7	59.7	151	114.0	99.1	211	159.2	138.4	271	204.5	177.8
32	24.2	21.0	92	69.4	60.4	52	114.7	99.7	12	160.0	139.1	72	205.3	178.4
33	24.9	21.6	93	70.2	61.0	53	115.5	100.4	13	160.8	139.7	73	206.0	179.1
34	25.7	22.3	94	70.9	61.7	54	116.2	101.0	14	161.5	140.4	74	206.8	179.8
35	26.4	23.0	95	71.7	62.3	55	117.0	101.7	15	162.3	141.1	75	207.5	180.4
36	27.2	23.6	96	72.5	63.0	56	117.7	102.3	16	163.0	141.7	76	208.3	181.1
37	27.9	24.3	97	73.2	63.6	57	118.5	103.0	17	163.8	142.4	77	209.1	181.7
38	28.7	24.9	98	74.0	64.3	58	119.2	103.7	18	164.5	143.0	78	209.8	182.4
39	29.4	25.6	99	74.7	64.9	59	120.0	104.3	19	165.3	143.7	79	210.6	183.0
40	30.2	26.2	100	75.5	65.6	60	120.8	105.0	20	166.0	144.3	80	211.3	183.7
41	30.9	26.9	101	76.2	66.3	161	121.5	105.6	221	166.8	145.0	281	212.1	184.4
42	31.7	27.6	02	77.0	66.9	62	122.3	106.3	22	167.5	145.6	82	212.8	185.0
43	32.5	28.2	03	77.7	67.6	63	123.0	106.9	23	168.3	146.3	83	213.6	185.7
44	33.2	28.9	04	78.5	68.2	64	123.8	107.6	24	169.1	147.0	84	214.3	186.3
45	34.0	29.5	05	79.2	68.9	65	124.5	108.2	25	169.8	147.6	85	215.1	187.0
46	34.7	30.2	06	80.0	69.5	66	125.3	108.9	26	170.6	148.3	86	215.8	187.6
47	35.5	30.8	07	80.8	70.2	67	126.0	109.6	27	171.3	148.9	87	216.6	188.3
48	36.2	31.5	08	81.5	70.9	68	126.8	110.2	28	172.1	149.6	88	217.4	188.9
49	37.0	32.1	09	82.3	71.5	69	127.5	110.9	29	172.8	150.2	89	218.1	189.6
50	37.7	32.8	10	83.0	72.2	70	128.3	111.5	30	173.6	150.9	90	218.9	190.3
51	38.5	33.5	111	83.8	72.8	171	129.1	112.2	231	174.3	151.5	291	219.6	190.9
52	39.2	34.1	12	84.5	73.5	72	129.8	112.8	32	175.1	152.2	92	220.4	191.6
53	40.0	34.8	13	85.3	74.1	73	130.6	113.5	33	175.8	152.9	93	221.1	192.2
54	40.8	35.4	14	86.0	74.8	74	131.3	114.2	34	176.6	153.5	94	221.9	192.9
55	41.5	36.1	15	86.8	75.4	75	132.1	114.8	35	177.4	154.2	95	222.6	193.5
56	42.3	36.7	16	87.5	76.1	76	132.8	115.5	36	178.1	154.8	96	223.4	194.2
57	43.0	37.4	17	88.3	76.8	77	133.6	116.1	37	178.9	155.5	97	224.1	194.8
58	43.8	38.1	18	89.1	77.4	78	134.3	116.8	38	179.6	156.1	98	224.9	195.5
59	44.5	38.7	19	89.8	78.1	79	135.1	117.4	39	180.4	156.8	99	225.7	196.2
60	45.3	39.4	20	90.6	78.7	80	135.8	118.1	40	181.1	157.5	300	226.4	196.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 49 Degrees.

Difference of Latitude and Departure for 42 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	45.3	40.8	121	89.9	81.0	181	134.5	121.1	241	179.1	161.3
2	01.5	01.3	62	46.1	41.5	22	90.7	81.6	82	135.3	121.8	42	179.8	161.9
3	02 2	02.0	63	46.8	42.2	23	91.4	82.3	83	136.0	122.5	43	180.6	162.6
4	03 0	02.7	64	47.6	42.8	24	92.1	83.0	84	136.7	123.1	44	181.3	163.3
5	03.7	03.3	65	48.3	43.5	25	92.9	83.6	85	137.5	123.8	45	182.1	163.9
6	04.5	04.0	66	49.0	44.2	26	93.6	84.3	86	138.2	124.5	46	182 8	164.6
7	05.2	04.7	67	49.8	44.8	27	94.4	85.0	87	139.0	125.1	47	183.6	165.3
8	05.9	05.4	68	50.5	45.5	28	95.1	85.6	88	139.7	125.8	48	184.3	165.9
9	06.7	06.0	69	51.3	46.2	29	95.9	86.3	89	140.5	126.5	49	185.0	166.6
10	07.4	06.7	70	52.0	46.8	30	96.6	87.0	90	141.2	127.1	50	185.8	167.3
11	08.2	07.4	71	52.8	47.5	131	97.4	87.7	191	141.9	127.8	251	186.5	168.0
12	08.9	08.0	72	53.5	48.2	32	98.1	88.3	92	142.7	128.5	52	187.3	168.6
13	09.7	08.7	73	54.2	48.8	33	98.8	89.0	93	143.4	129.1	53	188.0	169.3
14	10.4	09.4	74	55.0	49.5	34	99.6	89.7	94	144.2	129.8	54	188.8	170.0
15	11.1	10.0	75	55.7	50.2	35	100.3	90.3	95	144.9	130.5	55	189.5	170.6
16	11.9	10.7	76	56.5	50.9	36	101.1	91.0	96	145.7	131.1	56	190.2	171.3
17	12.6	11.4	77	57.2	51.5	37	101.8	91.7	97	146.4	131.8	57	191.0	172.0
18	13.4	12.0	78	58.0	52.2	38	102.6	92.3	98	147.1	132.5	58	191.7	172.6
19	14.1	12.7	79	58.7	52.9	39	103.3	93.0	99	147.9	133.2	59	192.5	173.3
20	14.9	13.4	80	59.5	53.5	40	104.0	93.7	200	148.6	133.8	60	193.2	174.0
21	15.6	14.1	81	60.2	54.2	141	104.8	94.3	201	149.4	134.5	261	194.0	174.6
22	16.3	14.7	82	60.9	54.9	42	105.5	95.0	02	150.1	135.2	62	194.7	175.3
23	17.1	15.4	83	61.7	55.5	43	106.3	95.7	03	150.9	135.8	63	195.4	176.0
24	17.8	16.1	84	62.4	56.2	44	107.0	96.4	04	151.6	136.5	64	196.2	176.7
25	18.6	16.7	85	63.2	56.9	45	107.8	97.0	05	152.3	137.2	65	196.9	177.3
26	19.3	17.4	86	63.9	57.5	46	108.5	97.7	06	153.1	137.8	66	197.7	178.0
27	20.1	18.1	87	64.7	58.2	47	109.2	98.4	07	153.8	138.5	67	198.4	178.7
28	20.8	18.7	88	65.4	58.9	48	110.0	99.0	08	154.6	139.2	68	199.2	179.3
29	21.6	19.4	89	66.1	59.6	49	110.7	99.7	09	155.3	139.8	69	199.9	180.0
30	22.3	20.1	90	66.9	60.2	50	111.5	100.4	10	156.1	140.5	70	200.6	180.7
31	23.0	20.7	91	67.6	60.9	151	112.2	101.0	211	156.8	141.2	271	201.4	181.3
32	23.8	21.4	92	68.4	61.6	52	113.0	101.7	12	157.5	141.9	72	202.1	182.0
33	24.5	22.1	93	69.1	62.2	53	113.7	102.4	13	158.3	142.5	73	202.9	182.7
34	25.3	22.8	94	69.9	62.9	54	114.4	103.0	14	159.0	143.2	74	203.6	183.3
35	26.0	23.4	95	70.6	63.6	55	115.2	103.7	15	159.8	143.9	75	204.4	184.0
36	26.8	24.1	96	71.3	64.2	56	115.9	104.4	16	160.5	144.5	76	205.1	184.7
37	27.5	24.8	97	72.1	64.9	57	116.7	105.1	17	161.3	145.2	77	205.9	185.3
38	28.2	25.4	98	72.8	65.6	58	117.4	105.7	18	162.0	145.9	78	206.6	186.0
39	29.0	26.1	99	73.6	66.2	59	118.2	106.4	19	162.7	146.5	79	207.3	186.7
40	29.7	26.8	100	74.3	66.9	60	118.9	107.1	20	163.5	147.2	80	208.1	187.4
41	30.5	27.4	101	75.1	67.6	161	119.6	107.7	221	164.2	147.9	281	208.8	188.0
42	31.2	28.1	02	75.8	68.3	62	120.4	108.4	22	165.0	148.5	82	209.6	188.7
43	32.0	28.8	03	76.5	68.9	63	121.1	109.1	23	165.7	149.2	83	210.3	189.4
44	32.7	29.4	04	77.3	69.6	64	121.9	109.7	24	166.5	149.9	84	211.1	190.0
45	33.4	30.1	05	78.0	70.3	65	122.6	110.4	25	167.2	150.6	85	211.8	190.7
46	34.2	30.8	06	78.8	70.9	66	123.4	111.1	26	168.0	151.2	86	212.5	191.4
47	34.9	31.4	07	79.5	71.6	67	124.1	111.7	27	168.7	151.9	87	213.3	192.0
48	35.7	32.1	08	80.3	72.3	68	124.8	112.4	28	169.4	152.6	88	214.0	192.7
49	36.4	32.8	09	81.0	72.9	69	125.6	113.1	29	170.2	153.2	89	214.8	193.4
50	37.2	33.5	10	81.7	73.6	70	126.3	113.8	30	170.9	153.9	90	215.5	194.0
51	37.9	34.1	111	82.5	74.3	171	127.1	114.4	231	171.7	154.6	291	216.3	194.7
52	38.6	34.8	12	83.2	74.9	72	127.8	115.1	32	172.4	155.2	92	217.0	195.4
53	39.4	35.5	13	84.0	75.6	73	128.6	115.8	33	173.2	155.9	93	217.7	196.1
54	40.1	36.1	14	84.7	76.3	74	129.3	116.4	34	173.9	156.6	94	218.5	196.7
55	40.9	36.8	15	85.5	77.0	75	130.1	117.1	35	174.6	157.2	95	219.2	197.4
56	41.6	37.5	16	86.2	77.6	76	130.8	117.8	36	175.4	157.9	96	220.0	198.1
57	42.4	38.1	17	86.9	78.3	77	131.5	118.4	37	176.1	158.6	97	220.7	198.7
58	43.1	38.8	18	87.7	79.0	78	132.3	119.1	38	176.9	159.3	98	221.5	199.4
59	43.8	39.5	19	88.4	79.6	79	133.0	119.8	39	177.6	159.9	99	222.2	200.1
60	44.6	40.1	20	89.2	80.3	80	133.8	120.4	40	178.4	160.6	300	222.9	200.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 48 Degrees.

Difference of Latitude and Departure for 43 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.4
2	01.5	01.4	62	45.3	42.3	22	89.2	83.2	82	133.1	124.1	42	177.0	165.0
3	02.2	02.0	63	46.1	43.0	23	90.0	83.9	83	133.8	124.8	43	177.7	165.7
4	02.9	02.7	64	46.8	43.6	24	90.7	84.6	84	134.6	125.5	44	178.5	166.4
5	03.7	03.4	65	47.5	44.3	25	91.4	85.2	85	135.3	126.2	45	179.2	167.1
6	04.4	04.1	66	48.3	45.0	26	92.2	85.9	86	136.0	126.9	46	179.9	167.8
7	05.1	04.8	67	49.0	45.7	27	92.9	86.6	87	136.8	127.5	47	180.6	168.5
8	05.9	05.5	68	49.7	46.4	28	93.6	87.3	88	137.5	128.2	48	181.4	169.1
9	06.6	06.1	69	50.5	47.1	29	94.3	88.0	89	138.2	128.9	49	182.1	169.8
10	07.3	06.8	70	51.2	47.7	30	95.1	88.7	90	139.0	129.6	50	182.8	170.5
11	08.0	07.5	71	51.9	48.4	131	95.8	89.3	191	139.7	130.3	251	183.6	171.2
12	08.8	08.2	72	52.7	49.1	32	96.5	90.0	92	140.4	130.9	52	184.3	171.9
13	09.5	08.9	73	53.4	49.8	33	97.3	90.7	93	141.2	131.6	53	185.0	172.5
14	10.2	09.5	74	54.1	50.5	34	98.0	91.4	94	141.9	132.3	54	185.8	173.2
15	11.0	10.2	75	54.9	51.1	35	98.7	92.1	95	142.6	133.0	55	186.5	173.9
16	11.7	10.9	76	55.6	51.8	36	99.5	92.8	96	143.3	133.7	56	187.2	174.6
17	12.4	11.6	77	56.3	52.5	37	100.2	93.4	97	144.1	134.4	57	188.0	175.3
18	13.2	12.3	78	57.0	53.2	38	100.9	94.1	98	144.8	135.0	58	188.7	176.0
19	13.9	13.0	79	57.8	53.9	39	101.7	94.8	99	145.5	135.7	59	189.4	176.6
20	14.6	13.6	80	58.5	54.6	40	102.4	95.5	200	146.3	136.4	60	190.2	177.3
21	15.4	14.3	81	59.2	55.2	141	103.1	96.2	201	147.0	137.1	261	190.9	178.0
22	16.1	15.0	82	60.0	55.9	42	103.9	96.8	02	147.7	137.8	62	191.6	178.7
23	16.8	15.7	83	60.7	56.6	43	104.6	97.5	03	148.5	138.4	63	192.3	179.4
24	17.6	16.4	84	61.4	57.3	44	105.3	98.2	04	149.2	139.1	64	193.1	180.0
25	18.3	17.0	85	62.2	58.0	45	106.0	98.9	05	149.9	139.8	65	193.8	180.7
26	19.0	17.7	86	62.9	58.7	46	106.8	99.6	06	150.7	140.5	66	194.5	181.4
27	19.7	18.4	87	63.6	59.3	47	107.5	100.3	07	151.4	141.2	67	195.3	182.1
28	20.5	19.1	88	64.4	60.0	48	108.2	100.9	08	152.1	141.9	68	196.0	182.8
29	21.2	19.8	89	65.1	60.7	49	109.0	101.6	09	152.9	142.5	69	196.7	183.5
30	21.9	20.5	90	65.8	61.4	50	109.7	102.3	10	153.6	143.2	70	197.5	184.1
31	22.7	21.1	91	66.6	62.1	151	110.4	103.0	211	154.3	143.9	271	198.2	184.8
32	23.4	21.8	92	67.3	62.7	52	111.2	103.7	12	155.0	144.6	72	198.9	185.5
33	24.1	22.5	93	68.0	63.4	53	111.9	104.3	13	155.8	145.3	73	199.7	186.2
34	24.9	23.2	94	68.7	64.1	54	112.6	105.0	14	156.5	145.9	74	200.4	186.9
35	25.6	23.9	95	69.5	64.8	55	113.4	105.7	15	157.2	146.6	75	201.1	187.5
36	26.3	24.6	96	70.2	65.5	56	114.1	106.4	16	158.0	147.3	76	201.9	188.2
37	27.1	25.2	97	70.9	66.2	57	114.8	107.1	17	158.7	148.0	77	202.6	188.9
38	27.8	25.9	98	71.7	66.8	58	115.6	107.8	18	159.4	148.7	78	203.3	189.6
39	28.5	26.6	99	72.4	67.5	59	116.3	108.4	19	160.2	149.4	79	204.0	190.3
40	29.3	27.3	100	73.1	68.2	60	117.0	109.1	20	160.9	150.0	80	204.8	191.0
41	30.0	28.0	101	73.9	68.9	161	117.7	109.8	221	161.6	150.7	281	205.5	191.6
42	30.7	28.6	02	74.6	69.6	62	118.5	110.5	22	162.4	151.4	82	206.2	192.3
43	31.4	29.3	03	75.3	70.2	63	119.2	111.2	23	163.1	152.1	83	207.0	193.0
44	32.2	30.0	04	76.1	70.9	64	119.9	111.8	24	163.8	152.8	84	207.7	193.7
45	32.9	30.7	05	76.8	71.6	65	120.7	112.5	25	164.6	153.4	85	208.4	194.4
46	33.6	31.4	06	77.5	72.3	66	121.4	113.2	26	165.3	154.1	86	209.2	195.1
47	34.4	32.1	07	78.3	73.0	67	122.1	113.9	27	166.0	154.8	87	209.9	195.7
48	35.1	32.7	08	79.0	73.7	68	122.9	114.6	28	166.7	155.5	88	210.6	196.4
49	35.8	33.4	09	79.7	74.3	69	123.6	115.3	29	167.5	156.2	89	211.4	197.1
50	36.6	34.1	10	80.4	75.0	70	124.3	115.9	30	168.2	156.9	90	212.1	197.8
51	37.3	34.8	111	81.2	75.7	171	125.1	116.6	231	168.9	157.5	291	212.8	198.5
52	38.0	35.5	12	81.9	76.4	72	125.8	117.3	32	169.7	158.2	92	213.6	199.1
53	38.8	36.1	13	82.6	77.1	73	126.5	118.0	33	170.4	158.9	93	214.3	199.8
54	39.5	36.8	14	83.4	77.7	74	127.3	118.7	34	171.1	159.6	94	215.0	200.5
55	40.2	37.5	15	84.1	78.4	75	128.0	119.3	35	171.9	160.3	95	215.7	201.2
56	41.0	38.2	16	84.8	79.1	76	128.7	120.0	36	172.6	161.0	96	216.5	201.9
57	41.7	38.9	17	85.6	79.8	77	129.4	120.7	37	173.3	161.6	97	217.2	202.6
58	42.4	39.6	18	86.3	80.5	78	130.2	121.4	38	174.1	162.3	98	217.9	203.2
59	43.1	40.2	19	87.0	81.2	79	130.9	122.1	39	174.8	163.0	99	218.7	203.9
60	43.9	40.9	20	87.8	81.8	80	131.6	122.8	40	175.5	163.7	300	219.4	204.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 47 Degrees.

Difference of Latitude and Departure for 44 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.9	42.4	121	87.0	84.1	181	130.2	125.7	241	173.4	167.4
2	01.4	01.4	62	44.6	43.1	22	87.8	84.7	82	130.9	126.4	42	174.1	168.1
3	02.2	02.1	63	45.3	43.8	23	88.5	85.4	83	131.6	127.1	43	174.8	168.8
4	02.9	02.8	64	46.0	44.5	24	89.2	86.1	84	132.4	127.8	44	175.5	169.5
5	03.6	03.5	65	46.8	45.2	25	89.9	86.8	85	133.1	128.5	45	176.2	170.2
6	04.3	04.2	66	47.5	45.8	26	90.6	87.5	86	133.8	129.2	46	177.0	170.9
7	05.0	04.9	67	48.2	46.5	27	91.4	88.2	87	134.5	129.9	47	177.7	171.6
8	05.8	05.6	68	48.9	47.2	28	92.1	88.9	88	135.2	130.6	48	178.4	172.3
9	06.5	06.3	69	49.6	47.9	29	92.8	89.6	89	136.0	131.3	49	179.1	173.0
10	07.2	06.9	70	50.4	48.6	30	93.5	90.3	90	136.7	132.0	50	179.8	173.7
11	07.9	07.6	71	51.1	49.3	131	94.2	91.0	191	137.4	132.7	251	180.6	174.4
12	08.6	08.3	72	51.8	50.0	32	95.0	91.7	92	138.1	133.4	52	181.3	175.1
13	09.4	09.0	73	52.5	50.7	33	95.7	92.4	93	138.8	134.1	53	182.0	175.7
14	10.1	09.7	74	53.2	51.4	34	96.4	93.1	94	139.6	134.8	54	182.7	176.4
15	10.8	10.4	75	54.0	52.1	35	97.1	93.8	95	140.3	135.5	55	183.4	177.1
16	11.5	11.1	76	54.7	52.8	36	97.8	94.5	96	141.0	136.2	56	184.2	177.8
17	12.2	11.8	77	55.4	53.5	37	98.5	95.2	97	141.7	136.8	57	184.9	178.5
18	12.9	12.5	78	56.1	54.2	38	99.3	95.9	98	142.4	137.5	58	185.6	179.2
19	13.7	13.2	79	56.8	54.9	39	100.0	96.6	99	143.1	138.2	59	186.3	179.9
20	14.4	13.9	80	57.5	55.6	40	100.7	97.3	200	143.9	138.9	60	187.0	180.6
21	15.1	14.6	81	58.3	56.3	141	101.4	97.9	201	144.6	139.6	261	187.7	181.3
22	15.8	15.3	82	59.0	57.0	42	102.1	98.6	02	145.3	140.3	62	188.5	182.0
23	16.5	16.0	83	59.7	57.7	43	102.9	99.3	03	146.0	141.0	63	189.2	182.7
24	17.3	16.7	84	60.4	58.4	44	103.6	100.0	04	146.7	141.7	64	189.9	183.4
25	18.0	17.4	85	61.1	59.0	45	104.3	100.7	05	147.5	142.4	65	190.6	184.1
26	18.7	18.1	86	61.9	59.7	46	105.0	101.4	06	148.2	143.1	66	191.3	184.8
27	19.4	18.8	87	62.6	60.4	47	105.7	102.1	07	148.9	143.8	67	192.1	185.5
28	20.1	19.5	88	63.3	61.1	48	106.5	102.8	08	149.6	144.5	68	192.8	186.2
29	20.9	20.1	89	64.0	61.8	49	107.2	103.5	09	150.3	145.2	69	193.5	186.9
30	21.6	20.8	90	64.7	62.5	50	107.9	104.2	10	151.1	145.9	70	194.2	187.6
31	22.3	21.5	91	65.5	63.2	151	108.6	104.9	211	151.8	146.6	271	194.9	188.3
32	23.0	22.2	92	66.2	63.9	52	109.3	105.6	12	152.5	147.3	72	195.7	188.9
33	23.7	22.9	93	66.9	64.6	53	110.1	106.3	13	153.2	148.0	73	196.4	189.6
34	24.5	23.6	94	67.6	65.3	54	110.8	107.0	14	153.9	148.7	74	197.1	190.3
35	25.2	24.3	95	68.3	66.0	55	111.5	107.7	15	154.7	149.4	75	197.8	191.0
36	25.9	25.0	96	69.1	66.7	56	112.2	108.4	16	155.4	150.0	76	198.5	191.7
37	26.6	25.7	97	69.8	67.4	57	112.9	109.1	17	156.1	150.7	77	199.3	192.4
38	27.3	26.4	98	70.5	68.1	58	113.7	109.8	18	156.8	151.4	78	200.0	193.1
39	28.1	27.1	99	71.2	68.8	59	114.4	110.5	19	157.5	152.1	79	200.7	193.8
40	28.8	27.8	100	71.9	69.5	60	115.1	111.1	20	158.3	152.8	80	201.4	194.5
41	29.5	28.5	101	72.7	70.2	161	115.8	111.8	221	159.0	153.5	281	202.1	195.2
42	30.2	29.2	02	73.4	70.9	62	116.5	112.5	22	159.7	154.2	82	202.9	195.9
43	30.9	29.9	03	74.1	71.5	63	117.3	113.2	23	160.4	154.9	83	203.6	196.6
44	31.7	30.6	04	74.8	72.2	64	118.0	113.9	24	161.1	155.6	84	204.3	197.3
45	32.4	31.3	05	75.5	72.9	65	118.7	114.6	25	161.9	156.3	85	205.0	198.0
46	33.1	32.0	06	76.3	73.6	66	119.4	115.3	26	162.6	157.0	86	205.7	198.7
47	33.8	32.6	07	77.0	74.3	67	120.1	116.0	27	163.3	157.7	87	206.5	199.4
48	34.5	33.3	08	77.7	75.0	68	120.8	116.7	28	164.0	158.4	88	207.2	200.1
49	35.2	34.0	09	78.4	75.7	69	121.6	117.4	29	164.7	159.1	89	207.9	200.8
50	36.0	34.7	10	79.1	76.4	70	122.3	118.1	30	165.4	159.8	90	208.6	201.5
51	36.7	35.4	111	79.8	77.1	171	123.0	118.8	231	166.2	160.5	291	209.3	202.1
52	37.4	36.1	12	80.6	77.8	72	123.7	119.5	32	166.9	161.2	92	210.0	202.8
53	38.1	36.8	13	81.3	78.5	73	124.4	120.2	33	167.6	161.9	93	210.8	203.5
54	38.8	37.5	14	82.0	79.2	74	125.2	120.9	34	168.3	162.6	94	211.5	204.2
55	39.6	38.2	15	82.7	79.9	75	125.9	121.6	35	169.0	163.2	95	212.2	204.9
56	40.3	38.9	16	83.4	80.6	76	126.6	122.3	36	169.8	163.9	96	212.9	205.6
57	41.0	39.6	17	84.2	81.3	77	127.3	123.0	37	170.5	164.6	97	213.6	206.3
58	41.7	40.3	18	84.9	82.0	78	128.0	123.6	38	171.2	165.3	98	214.4	207.0
59	42.4	41.0	19	85.6	82.7	79	128.8	124.3	39	171.9	166.0	99	215.1	207.7
60	43.2	41.7	20	86.3	83.4	80	129.5	125.0	40	172.6	166.7	300	215.8	208.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

[For 46 Degrees.

Difference of Latitude and Departure for 45 Degrees.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	22	86.3	86.3	82	128.7	128.7	42	171.1	171.1
3	02.1	02.1	63	44.5	44.5	23	87.0	87.0	83	129.4	129.4	43	171.8	171.8
4	02.8	02.8	64	45.3	45.3	24	87.7	87.7	84	130.1	130.1	44	172.5	172.5
5	03.5	03.5	65	46.0	46.0	25	88.4	88.4	85	130.8	130.8	45	173.2	173.2
6	04.2	04.2	66	46.7	46.7	26	89.1	89.1	86	131.5	131.5	46	173.9	173.9
7	04.9	04.9	67	47.4	47.4	27	89.8	89.8	87	132.2	132.2	47	174.7	174.7
8	05.7	05.7	68	48.1	48.1	28	90.5	90.5	88	132.9	132.9	48	175.4	175.4
9	06.4	06.4	69	48.8	48.8	29	91.2	91.2	89	133.6	133.6	49	176.1	176.1
10	07.1	07.1	70	49.5	49.5	30	91.9	91.9	90	134.4	134.4	50	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	32	93.3	93.3	92	135.8	135.8	52	178.2	178.2
13	09.2	09.2	73	51.6	51.6	33	94.0	94.0	93	136.5	136.5	53	178.9	178.9
14	09.9	09.9	74	52.3	52.3	34	94.8	94.8	94	137.2	137.2	54	179.6	179.6
15	10.6	10.6	75	53.0	53.0	35	95.5	95.5	95	137.9	137.9	55	180.3	180.3
16	11.3	11.3	76	53.7	53.7	36	96.2	96.2	96	138.6	138.6	56	181.0	181.0
17	12.0	12.0	77	54.4	54.4	37	96.9	96.9	97	139.3	139.3	57	181.7	181.7
18	12.7	12.7	78	55.2	55.2	38	97.6	97.6	98	140.0	140.0	58	182.4	182.4
19	13.4	13.4	79	55.9	55.9	39	98.3	98.3	99	140.7	140.7	59	183.1	183.1
20	14.1	14.1	80	56.6	56.6	40	99.0	99.0	200	141.4	141.4	60	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	42	100.4	100.4	02	142.8	142.8	62	185.3	185.3
23	16.3	16.3	83	58.7	58.7	43	101.1	101.1	03	143.5	143.5	63	186.0	186.0
24	17.0	17.0	84	59.4	59.4	44	101.8	101.8	04	144.2	144.2	64	186.7	186.7
25	17.7	17.7	85	60.1	60.1	45	102.5	102.5	05	145.0	145.0	65	187.4	187.4
26	18.4	18.4	86	60.8	60.8	46	103.2	103.2	06	145.7	145.7	66	188.1	188.1
27	19.1	19.1	87	61.5	61.5	47	103.9	103.9	07	146.4	146.4	67	188.8	188.8
28	19.8	19.8	88	62.2	62.2	48	104.7	104.7	08	147.1	147.1	68	189.5	189.5
29	20.5	20.5	89	62.9	62.9	49	105.4	105.4	09	147.8	147.8	69	190.2	190.2
30	21.2	21.2	90	63.6	63.6	50	106.1	106.1	10	148.5	148.5	70	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	52	107.5	107.5	12	149.9	149.9	72	192.3	192.3
33	23.3	23.3	93	65.8	65.8	53	108.2	108.2	13	150.6	150.6	73	193.0	193.0
34	24.0	24.0	94	66.5	66.5	54	108.9	108.9	14	151.3	151.3	74	193.7	193.7
35	24.7	24.7	95	67.2	67.2	55	109.6	109.6	15	152.0	152.0	75	194.5	194.5
36	25.5	25.5	96	67.9	67.9	56	110.3	110.3	16	152.7	152.7	76	195.2	195.2
37	26.2	26.2	97	68.6	68.6	57	111.0	111.0	17	153.4	153.4	77	195.9	195.9
38	26.9	26.9	98	69.3	69.3	58	111.7	111.7	18	154.1	154.1	78	196.6	196.6
39	27.6	27.6	99	70.0	70.0	59	112.4	112.4	19	154.9	154.9	79	197.3	197.3
40	28.3	28.3	100	70.7	70.7	60	113.1	113.1	20	155.6	155.6	80	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	02	72.1	72.1	62	114.6	114.6	22	157.0	157.0	82	199.4	199.4
43	30.4	30.4	03	72.8	72.8	63	115.3	115.3	23	157.7	157.7	83	200.1	200.1
44	31.1	31.1	04	73.5	73.5	64	116.0	116.0	24	158.4	158.4	84	200.8	200.8
45	31.8	31.8	05	74.2	74.2	65	116.7	116.7	25	159.1	159.1	85	201.5	201.5
46	32.5	32.5	06	75.0	75.0	66	117.4	117.4	26	159.8	159.8	86	202.2	202.2
47	33.2	33.2	07	75.7	75.7	67	118.1	118.1	27	160.5	160.5	87	202.9	202.9
48	33.9	33.9	08	76.4	76.4	68	118.8	118.8	28	161.2	161.2	88	203.6	203.6
49	34.6	34.6	09	77.1	77.1	69	119.5	119.5	29	161.9	161.9	89	204.4	204.4
50	35.4	35.4	10	77.8	77.8	70	120.2	120.2	30	162.6	162.6	90	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	12	79.2	79.2	72	121.6	121.6	32	164.0	164.0	92	206.5	206.5
53	37.5	37.5	13	79.9	79.9	73	122.3	122.3	33	164.8	164.8	93	207.2	207.2
54	38.2	38.2	14	80.6	80.6	74	123.0	123.0	34	165.5	165.5	94	207.9	207.9
55	38.9	38.9	15	81.3	81.3	75	123.7	123.7	35	166.2	166.2	95	208.6	208.6
56	39.6	39.6	16	82.0	82.0	76	124.5	124.5	36	166.9	166.9	96	209.3	209.3
57	40.3	40.3	17	82.7	82.7	77	125.2	125.2	37	167.6	167.6	97	210.0	210.0
58	41.0	41.0	18	83.4	83.4	78	125.9	125.9	38	168.3	168.3	98	210.7	210.7
59	41.7	41.7	19	84.1	84.1	79	126.6	126.6	39	169.0	169.0	99	211.4	211.4
60	42.4	42.4	20	84.9	84.9	80	127.3	127.3	40	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE III.

MERIDIONAL PARTS.

M.	0d.	1d.	2d.	3d.	4d.	5d.	6d.	7d.	8d.	9d.	10d.	11d.	12d.	13d.	M.
0	0	60	120	180	240	300	361	421	482	542	603	664	725	787	0
1	1	61	121	181	241	301	362	422	483	543	604	665	726	788	1
2	2	62	122	182	242	302	363	423	484	544	605	666	727	789	2
3	3	63	123	183	243	303	364	424	485	545	606	667	728	790	3
4	4	64	124	184	244	304	365	425	486	546	607	668	729	791	4
5	5	65	125	185	245	305	366	426	487	547	608	669	730	792	5
6	6	66	126	186	246	306	367	427	488	548	609	670	731	793	6
7	7	67	127	187	247	307	368	428	489	549	610	671	732	794	7
8	8	68	128	188	248	308	369	429	490	550	611	672	734	795	8
9	9	69	129	189	249	309	370	430	491	551	612	673	735	796	9
10	10	70	130	190	250	310	371	431	492	552	613	674	736	797	10
11	11	71	131	191	251	311	372	432	493	553	614	675	737	798	11
12	12	72	132	192	252	312	373	433	494	554	615	676	738	799	12
13	13	73	133	193	253	313	374	434	495	555	616	677	739	800	13
14	14	74	134	194	254	314	375	435	496	556	617	678	740	801	14
15	15	75	135	195	255	315	376	436	497	557	618	679	741	802	15
16	16	76	136	196	256	316	377	437	498	558	619	680	742	803	16
17	17	77	137	197	257	317	378	438	499	559	620	681	743	804	17
18	18	78	138	198	258	318	379	439	500	560	621	682	744	805	18
19	19	79	139	199	259	319	380	440	501	561	622	683	745	806	19
20	20	80	140	200	260	320	381	441	502	562	623	684	746	807	20
21	21	81	141	201	261	321	382	442	503	564	624	685	747	808	21
22	22	82	142	202	262	322	383	443	504	565	625	687	748	809	22
23	23	83	143	203	263	323	384	444	505	566	626	688	749	810	23
24	24	84	144	204	264	324	385	445	506	567	627	689	750	811	24
25	25	85	145	205	265	325	386	446	507	568	628	690	751	812	25
26	26	86	146	206	266	326	387	447	508	569	629	691	752	813	26
27	27	87	147	207	267	327	388	448	509	570	631	692	753	815	27
28	28	88	148	208	268	328	389	449	510	571	632	693	754	816	28
29	29	89	149	209	269	330	390	450	511	572	633	694	755	817	29
30	30	90	150	210	270	331	391	451	512	573	634	695	756	818	30
31	31	91	151	211	271	332	392	452	513	574	635	696	757	819	31
32	32	92	152	212	272	333	393	453	514	575	636	697	758	820	32
33	33	93	153	213	273	334	394	454	515	576	637	698	759	821	33
34	34	94	154	214	274	335	395	455	516	577	638	699	760	822	34
35	35	95	155	215	275	336	396	456	517	578	639	700	761	823	35
36	36	96	156	216	276	337	397	457	518	579	640	701	762	824	36
37	37	97	157	217	277	338	398	458	519	580	641	702	763	825	37
38	38	98	158	218	278	339	399	459	520	581	642	703	764	826	38
39	39	99	159	219	279	340	400	460	521	582	643	704	765	827	39
40	40	100	160	220	280	341	401	461	522	583	644	705	766	828	40
41	41	101	161	221	281	342	402	462	523	584	645	706	767	829	41
42	42	102	162	222	282	343	403	463	524	585	646	707	768	830	42
43	43	103	163	223	283	344	404	464	525	586	647	708	769	831	43
44	44	104	164	224	284	345	405	465	526	587	648	709	770	832	44
45	45	105	165	225	285	346	406	466	527	588	649	710	771	833	45
46	46	106	166	226	286	347	407	467	528	589	650	711	772	834	46
47	47	107	167	227	287	348	408	468	529	590	651	712	773	835	47
48	48	108	168	228	288	349	409	469	530	591	652	713	774	836	48
49	49	109	169	229	289	350	410	470	531	592	653	714	775	837	49
50	50	110	170	230	290	351	411	471	532	593	654	715	777	838	50
51	51	111	171	231	291	352	412	472	533	594	655	716	778	839	51
52	52	112	172	232	292	353	413	473	534	595	656	717	779	840	52
53	53	113	173	233	293	354	414	474	535	596	657	718	780	841	53
54	54	114	174	234	294	355	415	476	536	597	658	719	781	842	54
55	55	115	175	235	295	356	416	477	537	598	659	720	782	843	55
56	56	116	176	236	296	357	417	478	538	599	660	721	783	844	56
57	57	117	177	237	297	358	418	479	539	600	661	722	784	845	57
58	58	118	178	238	298	359	419	480	540	601	662	723	785	846	58
59	59	119	179	239	299	360	420	481	541	602	663	724	786	847	59
M.	0d.	1d.	2d.	3d.	4d.	5d.	6d.	7d.	8d.	9d.	10d.	11d.	12d.	13d.	M.

MERIDIONAL PARTS.

M.	14d.	15d.	16d.	17d.	18d.	19d.	20d.	21d.	22d.	23d.	24d.	25d.	26d.	27d.	M.
0	848	910	973	1035	1098	1161	1225	1289	1354	1419	1484	1550	1616	1684	0
1	850	911	974	36	99	63	26	90	55	20	85	51	18	85	1
2	851	913	975	37	1100	64	27	91	56	21	86	52	19	86	2
3	852	914	976	38	01	65	28	92	57	22	87	53	20	87	3
4	853	915	977	39	02	66	29	93	58	23	88	54	21	88	4
5	854	916	978	1041	1103	1167	1230	1295	1359	1424	1490	1556	1622	1689	5
6	855	917	979	42	05	68	32	96	60	25	91	57	23	90	6
7	856	918	980	43	06	69	33	97	61	26	92	58	24	91	7
8	857	919	981	44	07	70	34	98	62	27	93	59	25	93	8
9	858	920	982	45	08	71	35	99	63	28	94	60	26	94	9
10	859	921	983	1046	1109	1172	1236	1300	1364	1430	1495	1561	1628	1695	10
11	860	922	984	47	10	73	37	01	66	31	96	62	29	96	11
12	861	923	985	48	11	74	38	02	67	32	97	63	30	97	12
13	862	924	986	49	12	75	39	03	68	33	98	64	31	98	13
14	863	925	987	50	13	76	40	04	69	34	99	65	32	99	14
15	864	926	988	1051	1114	1177	1241	1305	1370	1435	1500	1567	1633	1700	15
16	865	927	989	52	15	78	42	06	71	36	02	68	34	01	16
17	866	923	990	53	16	79	43	07	72	37	03	69	35	03	17
18	867	929	991	54	17	81	44	08	73	38	04	70	37	04	18
19	868	930	993	55	18	82	45	10	74	39	05	71	38	05	19
20	869	931	994	1056	1119	1183	1246	1311	1375	1440	1506	1572	1639	1706	20
21	870	932	995	57	20	84	48	12	76	41	07	73	40	07	21
22	871	933	996	58	21	85	49	13	77	43	08	74	41	08	22
23	872	934	997	59	22	86	50	14	79	44	09	75	42	09	23
24	873	935	998	60	23	87	51	15	80	45	10	77	43	11	24
25	874	936	999	1061	1125	1188	1252	1316	1381	1446	1511	1578	1644	1712	25
26	875	937	1000	63	26	89	53	17	82	47	13	79	45	13	26
27	876	938	01	64	27	90	54	18	83	48	14	80	47	14	27
28	877	939	02	65	28	91	55	19	84	49	15	81	48	15	28
29	878	941	03	66	29	92	56	20	85	50	16	82	49	16	29
30	879	942	1004	1067	1130	1193	1257	1321	1386	1451	1517	1583	1650	1717	30
31	880	943	05	68	31	94	58	22	87	52	18	84	51	18	31
32	882	944	06	69	32	95	59	24	88	53	19	85	52	20	32
33	883	945	07	70	33	96	60	25	89	55	20	86	53	21	33
34	884	946	08	71	34	98	61	26	90	56	21	88	54	22	34
35	885	947	1009	1072	1135	1199	1262	1327	1392	1457	1522	1589	1656	1723	35
36	886	948	10	73	36	1200	64	28	93	58	24	90	57	24	36
37	837	949	11	74	37	01	65	29	94	59	25	91	58	25	37
38	888	950	12	75	38	02	66	30	95	60	26	92	59	26	38
39	889	951	13	76	39	03	67	31	96	61	27	93	60	27	39
40	890	952	1014	1077	1140	1204	1268	1332	1397	1462	1528	1594	1661	1729	40
41	891	953	15	78	41	05	69	33	98	63	29	95	62	30	41
42	892	954	16	79	42	06	70	34	99	64	30	96	63	31	42
43	893	955	18	80	44	07	71	35	1400	65	31	98	64	32	43
44	894	956	19	81	45	08	72	36	01	67	32	99	66	33	44
45	895	957	1020	1082	1146	1209	1273	1338	1402	1468	1533	1600	1667	1734	45
46	896	958	21	84	47	10	74	39	03	69	35	01	68	35	46
47	897	959	22	85	48	11	75	40	05	70	36	02	69	36	47
48	898	960	23	86	49	12	76	41	06	71	37	03	70	38	48
49	899	961	24	87	50	13	77	42	07	72	38	04	71	39	49
50	900	962	1025	1088	1151	1215	1278	1343	1408	1473	1539	1605	1672	1740	50
51	901	963	26	89	52	16	80	44	09	74	40	06	73	41	51
52	902	964	27	90	53	17	81	45	10	75	41	08	75	42	52
53	903	965	28	91	54	18	82	46	11	76	42	09	76	43	53
54	904	966	29	92	55	19	83	47	12	77	43	10	77	44	54
55	905	968	1030	1093	1156	1220	1284	1348	1413	1479	1544	1611	1678	1746	55
56	906	969	31	94	57	21	85	49	14	80	46	12	79	47	56
57	907	970	32	95	58	22	86	50	15	81	47	13	80	48	57
58	908	971	33	96	59	23	87	52	16	82	48	14	81	49	58
59	909	972	34	97	60	24	88	53	18	83	49	15	82	50	59
M.	14d.	15d.	16d.	17d.	18d.	19d.	20d.	21d.	22d.	23d.	24d.	25d.	26d.	27d.	M.

TABLE III.

MERIDIONAL PARTS.

M.	28d.	29d.	30d.	31d.	32d.	33d.	34d.	35d.	36d.	37d.	38d.	39d.	40d.	41d.	M.
0	1751	1819	1888	1958	2028	2100	2171	2244	2318	2393	2468	2545	2623	2702	0
1	52	21	90	59	30	01	73	46	19	94	70	46	24	03	1
2	53	22	91	60	31	02	74	47	20	95	71	48	25	04	2
3	55	23	92	62	32	03	75	48	22	96	72	49	27	06	3
4	56	24	93	63	33	04	76	49	23	98	73	50	28	07	4
5	1757	1825	1894	1964	2034	2105	2178	2250	2324	2399	2475	2551	2629	2708	5
6	58	26	95	65	35	07	79	52	25	2400	76	53	31	10	6
7	59	27	96	66	37	08	80	53	27	01	77	54	32	11	7
8	60	29	98	67	38	09	81	54	28	03	78	55	33	12	8
9	61	30	99	69	39	10	82	55	29	04	80	57	34	14	9
10	1762	1831	1900	1970	2040	2111	2184	2257	2330	2405	2481	2558	2636	2715	10
11	64	32	01	71	41	13	85	58	32	06	82	59	37	16	11
12	65	33	02	72	43	14	86	59	33	08	84	60	38	18	12
13	66	34	03	73	44	15	87	60	34	09	85	62	40	19	13
14	67	35	05	74	45	16	88	61	35	10	86	63	41	20	14
15	1768	1837	1906	1976	2046	2117	2190	2263	2337	2411	2487	2564	2642	2722	15
16	69	38	07	77	47	19	91	64	38	13	89	66	44	23	16
17	70	39	08	78	48	20	92	65	39	14	90	67	45	24	17
18	72	40	09	79	50	21	93	66	40	15	91	68	46	26	18
19	73	41	10	80	51	22	94	68	42	16	92	69	48	27	19
20	1774	1842	1912	1981	2052	2123	2196	2269	2343	2418	2494	2571	2649	2728	20
21	75	43	13	83	53	25	97	70	44	19	95	72	50	29	21
22	76	45	14	84	54	26	98	71	45	20	96	73	51	31	22
23	77	46	15	85	56	27	99	72	46	22	98	75	53	32	23
24	78	47	16	86	57	28	2200	74	48	23	99	76	54	33	24
25	1780	1848	1917	1987	2058	2129	2202	2275	2349	2424	2500	2577	2655	2735	25
26	81	49	18	88	59	31	03	76	50	25	01	78	57	36	26
27	82	50	20	90	60	32	04	77	51	27	03	80	58	37	27
28	83	52	21	91	61	33	05	79	53	28	04	81	59	39	28
29	84	53	22	92	63	34	07	80	54	29	05	82	61	40	29
30	1785	1854	1923	1993	2064	2135	2208	2281	2355	2430	2506	2584	2662	2742	30
31	86	55	24	94	65	37	09	82	56	32	08	85	63	43	31
32	87	56	25	95	66	38	10	83	58	33	09	86	65	44	32
33	89	57	27	97	67	39	11	85	59	34	10	88	66	46	33
34	90	58	28	98	69	40	13	86	60	35	12	89	67	47	34
35	1791	1860	1929	1999	2070	2141	2214	2287	2361	2437	2513	2590	2669	2748	35
36	92	61	30	2000	71	43	15	88	63	38	14	91	70	50	36
37	93	62	31	01	72	44	16	90	64	39	15	93	71	51	37
38	94	63	32	02	73	45	17	91	65	40	17	94	73	52	38
39	95	64	34	04	75	46	19	92	66	42	18	95	74	54	39
40	1797	1865	1935	2005	2076	2147	2220	2293	2368	2443	2519	2597	2675	2755	40
41	98	66	36	06	77	49	21	95	69	44	21	98	76	56	41
42	99	68	37	07	78	50	22	96	70	45	22	99	78	58	42
43	1800	69	38	08	79	51	24	97	71	47	23	2601	79	59	43
44	01	70	39	10	80	52	25	98	73	48	24	02	80	60	44
45	1802	1871	1941	2011	2082	2153	2226	2299	2374	2449	2526	2603	2682	2762	45
46	03	72	42	12	83	55	27	2301	75	51	27	04	83	63	46
47	05	73	43	13	84	56	28	02	76	52	28	06	84	64	47
48	06	75	44	14	85	57	30	03	78	53	30	07	86	66	48
49	07	76	45	15	86	58	31	04	79	54	31	08	87	67	49
50	1808	1877	1946	2017	2088	2159	2232	2306	2380	2456	2532	2610	2688	2768	50
51	09	78	48	18	89	61	33	07	81	57	33	11	90	70	51
52	10	79	49	19	90	62	35	08	83	58	35	12	91	71	52
53	11	80	50	20	91	63	36	09	84	59	36	14	92	72	53
54	13	81	51	21	92	64	37	11	85	61	37	15	94	74	54
55	1814	1883	1952	2022	2094	2165	2238	2312	2386	2462	2538	2616	2695	2775	55
56	15	84	53	24	95	67	39	13	88	63	40	17	96	76	56
57	16	85	55	25	96	68	41	14	89	64	41	19	98	78	57
58	17	86	56	26	97	69	42	16	90	66	42	20	99	79	58
59	18	87	57	27	98	70	43	17	91	67	44	21	2700	80	59
M.	28d.	29d.	30d.	31d.	32d.	33d.	34d.	35d.	36d.	37d.	38d.	39d.	40d.	41d.	M.

TABLE III.

MERIDIONAL PARTS.

M.	42d.	43d.	44d.	45d.	46d.	47d.	48d.	49d.	50d.	51d.	52d.	53d.	54d.	55d.	M.
0	2782	2863	2946	3030	3116	3203	3292	3382	3474	3569	3665	3764	3863	3968	0
1	83	64	47	31	17	04	93	84	76	70	67	65	66	70	1
2	84	66	49	33	18	06	95	85	78	72	68	67	68	71	2
3	86	67	50	34	20	07	96	87	79	74	70	69	70	73	3
4	87	69	51	36	21	09	98	88	81	75	72	70	71	75	4
5	2788	2870	2953	3037	3123	3210	3299	3390	3482	3577	3673	3772	3873	3977	5
6	90	71	54	38	24	12	3301	91	84	78	75	74	75	78	6
7	91	73	56	40	26	13	02	93	85	80	77	75	77	80	7
8	92	74	57	41	27	14	03	94	87	82	78	77	78	82	8
9	94	75	58	43	29	16	05	96	88	83	80	79	80	84	9
10	2795	2877	2960	3044	3130	3217	3306	3397	3490	3585	3681	3780	3882	3985	10
11	97	78	61	46	31	19	08	99	92	86	83	82	83	87	11
12	98	80	63	47	33	20	09	3400	93	88	85	84	85	89	12
13	99	81	64	48	34	22	11	02	95	90	86	85	87	91	13
14	2801	82	65	50	36	23	12	03	96	91	88	87	89	92	14
15	2802	2884	2967	3051	3137	3225	3314	3405	3498	3593	3690	3789	3890	3994	15
16	03	85	68	53	39	26	16	07	99	94	91	90	92	96	16
17	05	86	70	54	40	28	17	08	3501	96	93	92	94	98	17
18	06	88	71	55	42	29	19	10	03	98	95	94	95	99	18
19	07	89	72	57	43	31	20	11	04	99	96	95	97	4001	19
20	2809	2891	2974	3058	3144	3232	3322	3413	3506	3601	3698	3797	3899	4003	20
21	10	92	75	60	46	34	23	14	07	02	99	99	3901	05	21
22	11	93	76	61	47	35	25	16	09	04	3701	3800	02	06	22
23	13	95	78	63	49	37	26	17	10	06	03	02	04	08	23
24	14	96	79	64	50	38	28	19	12	07	04	04	06	10	24
25	2815	2897	2981	3065	3152	3240	3329	3420	3514	3609	3706	3806	3907	4012	25
26	17	99	82	67	53	41	31	22	15	10	08	07	09	14	26
27	18	2900	83	68	55	42	32	23	17	12	09	09	11	15	27
28	20	02	85	70	56	44	34	25	18	14	11	11	13	17	28
29	21	03	86	71	57	45	35	27	20	15	13	12	14	19	29
30	2822	2904	2988	3073	3159	3247	3337	3428	3521	3617	3714	3814	3916	4021	30
31	24	06	89	74	60	48	38	30	23	18	16	16	18	22	31
32	25	07	91	75	62	50	40	31	25	20	17	17	19	24	32
33	26	08	92	77	63	51	41	33	26	22	19	19	21	26	33
34	28	10	93	78	65	53	43	34	28	23	21	21	23	28	34
35	2829	2911	2995	3080	3166	3254	3344	3436	3529	3625	3722	3822	3925	4029	35
36	30	13	96	81	68	56	46	37	31	26	24	24	26	31	36
37	32	14	98	83	69	57	47	39	32	28	26	26	28	33	37
38	33	15	99	84	71	59	49	40	34	30	27	27	30	35	38
39	34	17	3000	85	72	60	50	42	36	31	29	29	32	37	39
40	2836	2918	3002	3087	3173	3262	3352	3443	3537	3633	3731	3831	3933	4038	40
41	37	19	03	88	75	63	53	45	39	34	32	32	35	40	41
42	39	21	05	90	76	65	55	47	40	36	34	34	37	42	42
43	40	22	06	91	78	66	56	48	42	38	36	36	38	44	43
44	41	24	07	93	79	68	58	50	43	39	37	38	40	45	44
45	2843	2925	3009	3094	3181	3269	3359	3451	3545	3641	3739	3839	3942	4047	45
46	44	26	10	95	82	71	61	53	47	43	41	41	44	49	46
47	45	28	12	97	84	72	62	54	48	44	42	43	45	51	47
48	47	29	13	98	85	74	64	56	50	46	44	44	47	52	48
49	48	31	14	3100	87	75	65	57	51	47	46	46	49	54	49
50	2849	2932	3016	3101	3188	3277	3367	3459	3553	3649	3747	3848	3951	4056	50
51	51	33	17	03	90	78	68	60	55	51	49	49	52	58	51
52	52	35	19	04	91	80	70	62	56	52	50	51	54	60	52
53	54	36	20	05	92	81	71	64	58	54	52	53	56	61	53
54	55	37	21	07	94	83	73	65	59	55	54	54	58	63	54
55	2856	2939	3023	3108	3195	3284	3374	3467	3561	3657	3755	3856	3959	4065	55
56	58	40	24	10	97	86	76	68	62	59	57	58	61	67	56
57	59	42	26	11	98	87	78	70	64	60	59	60	63	69	57
58	60	43	27	13	3200	89	79	71	66	62	60	61	64	70	58
59	62	44	29	14	01	90	81	73	67	64	62	63	66	72	59
M.	42d.	43d.	44d.	45d.	46d.	47d.	48d.	49d.	50d.	51d.	52d.	53d.	54d.	55d.	M.

TABLE III.

MERIDIONAL PARTS.

M.	56d.	57d.	58d.	59d.	60d.	61d.	62d.	63d.	64d.	65d.	66d.	67d.	68d.	69d.	M.
0	4074	4183	4294	4409	4527	4649	4775	4905	5039	5179	5324	5474	5631	5795	0
1	76	84	96	11	29	51	77	07	42	81	26	77	33	97	1
2	77	86	98	13	31	53	79	09	44	84	28	79	36	5800	2
3	79	88	4300	15	33	55	81	12	46	86	31	82	39	03	3
4	81	90	02	17	35	57	84	14	49	88	33	84	42	06	4
5	4083	4192	4304	4419	4537	4660	4786	4916	5051	5191	5336	5487	5644	5809	5
6	85	94	06	21	39	62	88	18	53	93	38	89	47	11	6
7	86	95	08	23	41	64	90	20	55	95	41	92	50	14	7
8	88	97	09	25	43	66	92	23	58	98	43	95	52	17	8
9	90	99	11	27	45	68	94	25	60	5200	46	97	55	20	9
10	4092	4201	4313	4429	4547	4670	4796	4927	5062	5203	5348	5500	5658	5823	10
11	94	03	15	31	49	72	98	29	65	05	51	02	60	25	11
12	95	05	17	33	51	74	4801	31	67	07	53	05	63	28	12
13	97	07	19	34	53	76	03	34	69	10	56	07	66	31	13
14	99	08	21	36	55	78	05	36	71	12	58	10	68	34	14
15	4101	4210	4323	4438	4557	4680	4807	4938	5074	5214	5361	5513	5671	5837	15
16	03	12	25	40	59	82	09	40	76	17	63	15	74	39	16
17	04	14	27	42	62	84	11	43	78	19	66	18	76	42	17
18	06	16	28	44	64	87	14	45	81	22	68	20	79	45	18
19	08	18	30	46	66	89	16	47	83	24	71	23	82	48	19
20	4110	4220	4332	4448	4568	4691	4818	4949	5085	5226	5373	5526	5685	5851	20
21	12	21	34	50	70	93	20	51	88	29	76	28	87	54	21
22	13	23	36	52	72	95	22	54	90	31	78	31	90	56	22
23	15	25	38	54	74	97	24	56	92	34	80	33	93	59	23
24	17	27	40	56	76	99	26	58	95	36	83	36	95	62	24
25	4119	4229	4342	4458	4578	4701	4829	4960	5097	5238	5385	5539	5698	5865	25
26	21	31	44	60	80	03	31	63	99	41	88	41	5701	68	26
27	22	32	46	62	82	05	33	65	5102	43	90	44	04	71	27
28	24	34	47	64	84	07	35	67	04	46	93	46	06	74	28
29	26	36	49	66	86	10	37	69	06	48	95	49	09	76	29
30	4128	4238	4351	4468	4588	4712	4839	4972	5108	5250	5398	5552	5712	5879	30
31	30	40	53	70	90	14	42	74	11	53	5401	54	15	82	31
32	32	42	55	72	92	16	44	76	13	55	03	57	17	85	32
33	33	44	57	74	94	18	46	78	15	58	06	59	20	88	33
34	35	46	59	76	96	20	48	81	18	60	08	62	23	91	34
35	4137	4247	4361	4478	4598	4722	4850	4983	5120	5263	5411	5565	5725	5894	35
36	39	49	63	80	4600	24	52	85	22	65	13	67	28	96	36
37	41	51	65	82	02	26	55	87	25	67	16	70	31	99	37
38	42	53	67	84	04	28	57	90	27	70	18	73	34	5902	38
39	44	55	69	86	06	31	59	92	29	72	21	75	36	05	39
40	4146	4257	4370	4488	4608	4733	4861	4994	5132	5275	5423	5578	5739	5908	40
41	48	59	72	90	10	35	63	96	34	77	26	80	42	11	41
42	50	60	74	92	12	37	65	99	36	80	28	83	45	14	42
43	52	62	76	94	14	39	68	5001	39	82	31	86	47	17	43
44	53	64	78	95	16	41	70	03	41	84	33	88	50	19	44
45	4155	4266	4380	4497	4618	4743	4872	5005	5143	5287	5436	5591	5753	5922	45
46	57	68	82	99	20	45	74	08	46	89	38	94	56	25	46
47	59	70	84	4501	23	47	76	10	48	92	41	96	58	28	47
48	61	72	86	03	25	50	79	12	51	94	43	99	61	31	48
49	62	74	88	05	27	52	81	14	53	97	46	5602	64	34	49
50	4164	4275	4390	4507	4629	4754	4883	5017	5155	5299	5448	5604	5767	5937	50
51	66	77	92	09	31	56	85	19	58	5301	51	07	70	40	51
52	68	79	94	11	33	58	87	21	60	04	54	10	72	43	52
53	70	81	96	13	35	60	90	23	62	06	56	12	75	46	53
54	72	83	98	15	37	62	92	26	65	09	59	15	78	48	54
55	4173	4285	4399	4517	4639	4764	4894	5028	5167	5311	5461	5617	5781	5951	55
56	75	87	4401	19	41	66	96	30	69	14	64	20	83	54	56
57	77	89	03	21	43	69	98	33	72	16	66	23	86	57	57
58	79	91	05	23	45	71	4901	35	74	19	69	25	89	60	58
59	81	92	07	25	47	73	03	37	76	21	71	28	92	63	59
M.	56d.	57d.	58d.	59d.	60d.	61d.	62d.	63d.	64d.	65d.	66d.	67d.	68d.	69d.	M.

TABLE III.

MERIDIONAL PARTS.

M.	70d.	71d.	72d.	73d.	74d.	75d.	76d.	77d.	78d.	79d.	80d.	81d.	82d.	83d.	M.
0	5966	6146	6335	6534	6746	6970	7210	7467	7745	8046	8375	8739	9145	9606	0
1	69	49	38	38	49	74	14	72	49	51	81	45	53	14	1
2	72	52	41	41	53	78	18	76	54	56	87	52	60	22	2
3	75	55	45	45	57	82	22	81	59	61	93	58	67	31	3
4	78	58	48	48	60	86	27	85	64	67	98	65	74	39	4
5	5981	6161	6351	6552	6764	6990	7231	7490	7769	8072	8404	8771	9182	9647	5
6	84	64	54	55	68	94	35	94	74	77	10	78	89	55	6
7	86	67	58	58	71	97	39	98	78	83	16	84	96	64	7
8	89	70	61	62	75	7001	43	7503	83	88	22	91	9203	72	8
9	92	73	64	65	79	05	47	07	88	93	27	97	11	80	9
10	5995	6177	6367	6569	6782	7009	7252	7512	7793	8099	8433	8804	9218	9689	10
11	98	80	71	72	86	13	56	16	98	8104	39	10	25	97	11
12	6001	83	74	76	90	17	60	21	7803	09	45	17	33	9706	12
13	04	86	77	79	93	21	64	25	08	15	51	23	40	14	13
14	07	89	80	83	97	25	68	30	13	20	57	30	48	23	14
15	6010	6192	6384	6586	6801	7029	7273	7535	7817	8125	8463	8836	9255	9731	15
16	13	95	87	90	04	33	77	39	22	31	69	43	62	40	16
17	16	98	90	93	08	37	81	44	27	36	74	49	70	48	17
18	19	6201	94	97	12	41	85	48	32	41	80	56	77	57	18
19	22	05	97	6600	15	45	89	53	37	47	86	63	85	65	19
20	6025	6208	6400	6603	6819	7048	7294	7557	7842	8152	8492	8869	9292	9774	20
21	28	11	03	07	23	52	98	62	47	58	98	76	9300	83	21
22	31	14	07	10	26	56	7302	66	52	63	8504	83	07	91	22
23	34	17	10	14	30	60	06	71	57	68	10	89	15	9800	23
24	37	20	13	17	34	64	11	76	62	74	16	96	22	09	24
25	6040	6223	6417	6621	6838	7068	7315	7580	7867	8179	8522	8903	9330	9817	25
26	43	26	20	24	41	72	19	85	72	85	28	09	37	26	26
27	46	30	23	28	45	76	23	89	77	90	34	16	45	35	27
28	49	33	27	31	49	80	28	94	82	96	40	23	53	44	28
29	52	36	30	35	53	84	32	99	87	8201	46	30	60	52	29
30	6055	6239	6433	6639	6856	7088	7336	7603	7892	8207	8552	8936	9368	9861	30
31	58	42	37	42	60	92	41	08	97	12	58	43	76	70	31
32	61	45	40	46	64	96	45	12	7902	18	65	50	83	79	32
33	64	49	43	49	68	7100	49	17	07	23	71	57	91	88	33
34	67	52	47	53	71	04	53	22	12	29	77	63	99	97	34
35	6070	6255	6450	6656	6875	7108	7358	7626	7917	8234	8583	8970	9407	9906	35
36	73	58	53	60	79	12	62	31	22	40	89	77	14	15	36
37	76	61	57	63	83	16	66	36	27	45	95	84	22	24	37
38	79	64	60	67	86	20	71	40	32	51	8601	91	30	33	38
39	82	68	63	70	90	24	75	45	37	56	07	98	38	42	39
40	6085	6271	6467	6674	6894	7128	7379	7650	7942	8262	8614	9005	9445	9951	40
41	88	74	70	77	98	32	84	54	48	67	20	12	53	60	41
42	91	77	73	81	6901	36	88	59	53	73	26	18	61	69	42
43	94	80	77	85	05	40	92	64	58	79	32	25	69	78	43
44	97	83	80	88	09	45	97	68	63	84	38	32	77	87	44
45	6100	6287	6483	6692	6913	7149	7401	7673	7968	8290	8644	9039	9485	9996	45
46	03	90	87	95	17	53	06	78	73	95	51	46	93	10005	46
47	06	93	90	99	20	57	10	83	78	8301	57	53	9501	10015	47
48	09	96	94	6702	24	61	14	87	83	07	63	60	09	10024	48
49	12	99	97	06	23	65	19	92	89	12	69	67	17	10033	49
50	6115	6303	6500	6710	6932	7169	7423	7697	7994	8318	8676	9074	9525	10043	50
51	18	06	04	13	36	73	27	7702	99	24	82	81	33	10052	51
52	21	09	07	17	40	77	32	06	8004	29	88	88	41	10061	52
53	24	12	11	20	43	81	36	11	09	35	95	96	49	10071	53
54	27	15	14	24	47	85	41	16	14	41	8701	9103	57	10080	54
55	6130	6319	6517	6728	6951	7189	7445	7721	8020	8347	8707	9110	9565	10089	55
56	33	22	21	31	55	94	49	25	25	52	14	17	73	10099	56
57	36	25	24	35	59	98	54	30	30	58	20	24	81	10108	57
58	40	28	28	38	63	7202	58	35	35	64	26	31	89	10118	58
59	43	32	31	42	66	06	63	40	40	69	33	38	98	10127	59
M.	70d.	71d.	72d.	73d.	74d.	75d.	76d.	77d.	78d.	79d.	80d.	81d.	82d.	83d.	M.

TABLE IV. THE SUN'S DECLINATION

FOR THE YEAR 1824,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1820, 1828, 1832, 1836.

DAYS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	DAYS.
	South.	South.	South.	North.	North.	North.	North.	North.	North.	South.	South.	South.	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 5	17.18	7.29	4.38	15. 9	22. 6	23. 7	18.00	8.14	3.16	14.31	21.52	1
2	23.00	17. 1	7. 6	5. 1	15.27	22.14	23. 3	17.45	7.52	3.39	14.50	22. 1	2
3	22.55	16.44	6.43	5.24	15.45	22.21	22.58	17.29	7.30	4. 3	15. 9	22.10	3
4	22.49	16.26	6.20	5.47	16. 2	22.28	22.53	17.13	7. 8	4.26	15.28	22.18	4
5	22.42	16. 8	5.57	6.10	16.19	22.35	22.48	16.57	6.45	4.49	15.46	22.26	5
6	22.36	15.50	5.34	6.33	16.36	22.41	22.42	16.41	6.23	5.12	16. 4	22.33	6
7	22.29	15.32	5.10	6.55	16.53	22.47	22.36	16.24	6. 1	5.35	16.22	22.40	7
8	22.21	15.13	4.47	7.18	17. 9	22.53	22.29	16. 7	5.38	5.58	16.40	22.46	8
9	22.13	14.54	4.23	7.40	17.25	22.58	22.22	15.50	5.15	6.21	16.57	22.52	9
10	22. 5	14.35	4.00	8. 2	17.41	23. 3	22.14	15.32	4.53	6.44	17.14	22.58	10
11	21.56	14.15	3.36	8.24	17.56	23. 7	22. 7	15.15	4.30	7. 6	17.31	23. 3	11
12	21.46	13.56	3.13	8.46	18.12	23.11	21.58	14.57	4. 7	7.29	17.47	23. 7	12
13	21.37	13.36	2.49	9. 8	18.27	23.14	21.50	14.38	3.44	7.52	18. 3	23.11	13
14	21.26	13.16	2.26	9.30	18.41	23.18	21.41	14.20	3.21	8.14	18.19	23.15	14
15	21.16	12.55	2. 2	9.51	18.55	23.20	21.32	14. 1	2.58	8.36	18.34	23.18	15
16	21. 5	12.35	1.38	10.12	19. 9	23.23	21.22	13.42	2.35	8.58	18.49	23.21	16
17	20.54	12.14	1.15	10.33	19.23	23.24	21.12	13.23	2.11	9.21	19. 4	23.23	17
18	20.42	11.53	0.51	10.54	19.36	23.26	21. 1	13. 4	1.48	9.42	19.18	23.25	18
19	20.30	11.32	0.27	11.15	19.49	23.27	20.51	12.44	1.25	10. 4	19.33	23.26	19
20	20.17	11.11	0. 4S	11.36	20. 2	23.28	20.39	12.25	1. 1	10.26	19.46	23.27	20
21	20. 4	10.49	0.20N	11.56	20.14	23.28	20.28	12. 5	0.38	10.47	20.00	23.28	21
22	19.51	10.27	0.44	12.16	20.26	23.28	20.16	11.44	0.15N	11. 9	20.13	23.28	22
23	19.37	10. 6	1. 8	12.36	20.38	23.27	20. 4	11.24	0. 9S	11.30	20.25	23.27	23
24	19.23	9.44	1.31	12.56	20.49	23.26	19.52	11. 4	0.32	11.51	20.37	23.26	24
25	19. 9	9.21	1.55	13.16	21.00	23.25	19.39	10.43	0.56	12.12	20.49	23.25	25
26	18.54	8.59	2.18	13.35	21.10	23.23	19.26	10.22	1.19	12.32	21. 1	23.23	26
27	18.39	8.37	2.42	13.54	21.20	23.20	19.12	10. 1	1.43	12.53	21.12	23.20	27
28	18.23	8.14	3. 5	14.13	21.30	23.18	18.58	9.40	2. 6	13.13	21.23	23.17	28
29	18. 8	7.52	3.29	14.32	21.40	23.15	18.44	9.19	2.29	13.33	21.33	23.14	29
30	17.51		3.52	14.51	21.49	23.11	18.30	8.57	2.53	13.52	21.43	23.10	30
31	17.35		4.15		21.57		18.15	8.35		14.12		23. 6	31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1824,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1828, 1832, 1836.

DAYS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	DAYS.
	Add to ap. tim	Add to ap. tim	Add to ap. tim	Add to ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Add to ap. tim	Add to ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	
	M. S.	M. S.	M. S.	M. S	M. S.	M. S.	M. S.	M. S.	M. S	M. S.	M. S.	M. S.	
1	3.35	13.52	12.36	3.55	3. 5	2.35	3.25	5.58	0.12	10.25	16.15	10.37	1
2	4. 1	14. 1	12.24	3.37	3.12	2.24	3.37	5.54	0.31	10.41	16.16	10.14	2
3	4.32	14. 8	12.11	3.19	3.19	2.14	3.48	5.50	0.51	11.00	16.16	9.51	3
4	5. 0	14.14	11.58	3. 1	3.25	2. 5	3.59	5.45	1.10	11.18	16.15	9.26	4
5	5.27	14.20	11.44	2.44	3.31	1.51	4. 9	5.39	1.30	11.36	16.14	9. 2	5
6	5.54	14.25	11.30	2.26	3.36	1.44	4.19	5.33	1.50	11.54	16.11	8.36	6
7	6.21	14.29	11.15	2. 9	3.41	1.33	4.29	5.26	2.10	12.11	16. 8	8.10	7
8	6.47	14.32	11.00	1.51	3.45	1.22	4.39	5.18	2.30	12.28	16. 4	7.44	8
9	7.13	14.34	10.45	1.34	3.48	1.11	4.48	5.10	2.51	12.44	15.59	7.17	9
10	7.38	14.36	10.29	1.18	3.51	0.59	4.58	5. 2	3.12	13.00	15.53	6.50	10
11	8. 2	14.36	10.13	1. 1	3.53	0.47	5. 4	4.53	3.32	13.15	15.46	6.22	11
12	8.26	14.36	9.57	0.45	3.55	0.35	5.12	4.43	3.53	13.30	15.38	5.54	12
13	8.4[illegible]	14.35	9.40	0.2[illegible]	3.56	0.23	5.19	4.32	4.14	13.44	15.30	5.26	13
14	9.11	14.34	9.23	0.14	3.57	0.10	5.26	4.22	4.35	13.58	15.21	4.57	14
15	9.33	14.31	9. 6	sub0. 2	3.57	add0.02	5.32	4.10	4.56	14.11	15.10	4.28	15
16	9.54	14.28	8.48	0.16	3.56	0.15	5.3[illegible]	3.58	5.17	14.24	14.59	3.58	16
17	10.1[illegible]	14.24	8.30	0.31	3.55	0.28	5.11	3.46	5.3[illegible]	14.36	14.47	3.29	17
18	[illegible]	14.21	8.13	0.45	3.54	0.40	5.49	3.33	5.59	14.47	14.35	2.59	18
19	10.54	14.15	7.54	0.59	3.51	[illegible]	5.53	3.20	6.2[illegible]	14.58	14.21	2.29	19
20	11.12	14. 9	7.36	1.12	3.48	1. 6	5.57	3. 6	6.41	15. 8	14. 6	1.5[illegible]	20
21	11.30	14. 2	7.18	1.25	3.45	1.19	6.0[illegible]	2.52	7. 2	15.18	13.51	1.29	21
22	11.46	13.55	7.00	1.37	3.41	1.32	6. 3	2.37	7.23	15.26	13.35	0.59	22
23	12. 3	13.47	6.41	1.49	3.36	1.45	6. 5	2.22	7.44	15.35	13.18	0.28	23
24	12.18	13.39	6.23	2.00	3.31	1.58	6. 7	2. 6	8. 4	15.42	13. 1	add0. 2	24
25	12.33	13.3[illegible]	6. 4	2.11	3.26	2.11	6. 8	1.50	8.24	15.49	12.42	0.32	25
26	12.46	13.20	5.46	2.21	3.20	2.24	6. 8	1.34	8.45	15.55	12.23	1. 2	26
27	12.5[illegible]	13.10	5.27	2.31	3.13	2.37	6. 8	1.17	9. 5	16.00	12. 3	1.31	27
28	13.12	12.59	5. 9	2.40	3. 6	2.49	6. 7	1.00	9.24	16. 5	11.43	2. 1	28
29	13.23	12.48	4.50	2.49	2.58	3. 1	6. 6	0.42	9.44	16. 8	11.22	2.30	29
30	13.34		4.32	2.56	2.50	3.13	6. 4	0.24	10. 3	16.12	11.00	2.58	30
31	13.41		4.15		2.1[illegible]		6. 1	0. 6		16.14		3.2[illegible]	31

TABLE IV. THE SUN'S DECLINATION

FOR THE YEAR 1825,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1829, 1833, 1837.

DAYS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	DAYS.
	South.	South.	South.	North.	North.	North.	North.	North.	North.	South.	South.	South.	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 1	17. 5	7.34	4.33	15. 4	22. 4	23. 8	18. 4	8.19	3.10	14.27	21.50	1
2	22.56	16.48	7.11	4.56	15.22	22.12	23. 4	17.48	7.57	3.34	14.46	21.59	2
3	22.50	16.31	6.49	5.19	15.40	22.19	23.00	17.33	7.35	3.57	15. 5	22. 8	3
4	22.44	16.13	6.26	5.42	15.58	22.26	22.55	17.17	7.13	4.20	15.23	22.16	4
5	22.37	15.55	6. 2	6. 4	16.15	22.33	22.49	17. 1	6.51	4.43	15.42	22.24	5
6	22.30	15.36	5.39	6.27	16.32	22.40	22.43	16.45	6.29	5. 7	16.00	22.31	6
7	22.23	15.18	5.16	6.50	16.49	22.46	22.37	16.28	6. 6	5.30	16.18	22.38	7
8	22.15	14.59	4.53	7.12	17. 5	22.51	22.31	16.11	5.44	5.53	16.35	22.45	8
9	22. 7	14.40	4.29	7.34	17.21	22.57	22.24	15.54	5.21	6.15	16.53	22.51	9
10	21.58	14.20	4. 6	7.57	17.37	23. 1	22.16	15.37	4.58	6.38	17.10	22.56	10
11	21.49	14. 1	3.42	8.19	17.53	23. 6	22. 9	15.19	4.35	7. 1	17.27	23. 1	11
12	21.39	13.41	3.19	8.41	18. 8	23.10	22.00	15. 1	4.12	7.24	17.43	23. 6	12
13	21.29	13.21	2.55	9. 3	18.23	23.14	21.52	14.43	3.49	7.46	17.59	23.10	13
14	21.18	13.00	2.31	9.24	18.37	23.17	21.43	14.24	3.26	8. 9	18.15	23.14	14
15	21. 8	12.40	2. 8	9·46	18.52	23.20	21.34	14. 6	3. 3	8.31	18.31	23.18	15
16	20.56	12.19	1.44	10. 7	19. 6	23.22	21.24	13.47	2.40	8.53	18.46	23.20	16
17	20.45	11.58	1.20	10.28	19.20	23.24	21.14	13.28	2.17	9.15	19. 1	23.23	17
18	20.33	11.37	0.57	10.49	19.33	23.26	21. 4	13. 8	1.54	9.37	19.15	23.25	18
19	20.20	11.16	0.33	11.10	19.46	23.27	20.53	12.49	1.30	9.59	19.29	23.26	19
20	20. 7	10.54	0. 9S	11.31	19.59	23.27	20.42	12.29	1. 7	10.21	19.43	23.27	20
21	19.54	10.33	0.15N	11.51	20.11	23.28	20.31	12. 9	0.44	10.42	19.56	23.28	21
22	19.40	10.11	0.38	12.12	20.23	23.28	20.19	11.49	0.20N	11. 4	20 10	23.28	22
23	19.26	9.49	1. 2	12.32	20.35	23.27	20. 7	11.29	0. 3S	11.25	20.22	23.27	23
24	19.12	9.27	1.25	12.52	20.46	23.26	19.55	11. 9	0.27	11.46	20.35	23.26	24
25	18.57	9. 5	1.49	13.11	20.57	23.25	19.42	10.48	0.50	12. 7	20.46	23.25	25
26	18.42	8.42	2.13	13.31	21. 8	23.23	19.29	10.27	1.13	12.27	20.58	23.23	26
27	18.27	8.20	2.36	13.50	21.18	23.21	19.15	10. 6	1.37	12.48	21. 9	23.21	27
28	18.11	7.57	3.00	14. 9	21.28	23.18	19. 2	9.45	2.00	13. 8	21.20	23.18	28
29	17.55		3.23	14.28	21.37	23.15	18.48	9.24	2.24	13.28	21.30	23.15	29
30	17.39		3.46	14.46	21.46	23.12	18.33	9. 2	2.47	13.48	21.40	23.11	30
31	17.22		4. 9		21.55		18.19	8.41		14. 7		23. 7	31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1825,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1829, 1833, 1837.

DAYS.	Jan.	Feb.	March.	April.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	DAYS.
	Add to ap. tim	Add to ap. tim	Add to ap. tim	Add to ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Add to ap. tim	Add to ap. tim	Sub. fr ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	
	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	
1	3.57	13.58	12.30	3.59	3. 4	2.37	3.21	5.58	0. 9	10.18	16.15	10.42	1
2	4.25	14. 6	12.27	3.41	3.12	2.28	3.32	5.54	0 28	10.37	16.16	[illegible]	2
3	4.53	14.12	12.14	3.23	3.19	2.18	3.43	5.50	0.47	10.56	16.16	9.56	3
4	5.20	14.18	12. 1	3. 5	3.25	2. 9	3.54	5.45	1. 6	11.14	16.15	9.32	4
5	5.47	14.23	11.47	2.47	3.31	1.59	4. 5	5.39	1.26	11.32	16.14	9. 7	5
6	6.13	14.27	11.33	2.29	3.36	1.48	4.15	5.33	1.46	11.50	16.11	8.42	6
7	6.39	14.30	11.18	2.12	3.41	1.37	4.25	5.26	2. 6	12. 7	16. 8	8.16	7
8	7. 5	14.32	11. 3	1.54	3.45	1.26	4.34	5.19	2.26	12.23	16. 4	7.49	8
9	7.30	14.34	10.48	1.37	3.49	1.15	4.44	5.11	2.46	12.39	15.59	7.22	9
10	7.55	14.35	10.32	1.21	3.52	1. 3	4.52	5. 3	3. 7	12.55	15.53	6.55	10
11	8.18	14.35	10.16	1. 4	3.54	0.51	5. 1	4.54	3.27	13.11	15.46	6.27	11
12	8.42	14.35	10. 0	0.48	3.56	0.39	5. 9	4.45	3.48	13.25	15.39	5.59	12
13	9. 5	14.33	9.43	0.32	3.57	0.27	5.17	4.35	4. 9	13.40	15.30	5.31	13
14	9.27	14.31	9.26	0.17	3.58	0.14	5.24	4.24	4.29	13.53	15.21	5. 2	14
15	9.48	14.29	9. 9	0. 2	3.58	0. 2	5.30	4.13	4.50	14. 7	15.11	4.33	15
16	10. 9	14.25	8.52	sub0.13	3.57	add0.11	5.37	4. 1	5.11	14.19	15. 0	4. 3	16
17	10.29	14.21	8.35	0.28	3.56	0 24	5.42	3.49	5.32	14.31	14.48	3.34	17
18	10.49	14.16	8.17	0.41	3.54	0.37	5.47	3.37	5.53	14.43	14.36	3. 4	18
19	11. 7	14.10	7.59	0.55	3.52	0.50	5.52	3.23	6.14	14.54	14.23	2.35	19
20	11.25	14. 4	7.41	1. 8	3.49	1. 3	5.56	3.10	6.35	15. 4	14. 8	2. 5	20
21	11.43	13.57	7.23	1.21	3.46	1.16	5.59	2.56	6.56	15.14	13.54	1.35	21
22	11.59	13.50	7. 5	1.33	3.42	1.29	6. 2	2.41	7.17	15.23	13.38	1. 5	22
23	12.15	13.41	6.46	1.45	3.37	1.42	6. 4	2.26	7.38	15.32	13.21	0.35	23
24	12.30	13.32	6.28	1.57	3.32	1.55	6. 6	2.10	7.59	15.39	13. 4	0. 5	24
25	12.44	13.23	6. 9	2. 8	3.27	2. 8	6. 7	1.54	8.19	15.46	12.46	add0.25	25
26	12.57	13.13	5.51	2.18	3.21	2.20	6. 8	1.38	8.40	15.53	12.27	0.55	26
27	13. 9	13. 2	5.32	2.29	3.15	2.33	6. 7	1.21	9. 0	15.58	12. 8	1.24	27
28	13.21	12.51	5.14	2 38	3. 8	2.45	6. 7	1. 4	9.20	16. 3	11.48	1.54	28
29	13.31		4.55	2.47	3. 1	2.57	6. 5	0.46	9.40	16. 7	11.27	2.23	29
30	13.41		4.36	2.56	2.53	3. 9	6. 3	0.28	9.59	16.11	11. 5	2.52	30
31	13.50		4.18		2.45		6. 1	0.10		16.13		3.21	31

TABLE IV. THE SUN'S DECLINATION

FOR THE YEAR 1826,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1830, 1834, 1838.

DAYS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	DAYS.
	South.	South.	South.	North.	North.	North.	North.	North.	North.	South.	South.	South.	
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
1	23. 2	17.10	7.40	4.27	15.00	22. 2	23. 9	18. 7	8.24	3. 5	14.22	21.47	1
2	22.57	16.52	7.17	4.50	15.18	22.10	23. 5	17.52	8. 3	3.28	14.41	21.57	2
3	22.51	16.35	6.54	5.13	15.36	22.17	23. 1	17.37	7.41	3.51	15.00	22. 5	3
4	22.45	16.17	6.31	5.36	15.53	22.25	22.56	17.21	7.18	4.15	15.19	22.14	4
5	22.39	15.59	6. 8	5.59	16.11	22.32	22.50	17. 5	6.56	4.38	15.37	22.22	5
6	22.32	15.41	5.45	6.22	16.28	22.38	22.45	16.49	6.34	5. 1	15.56	22.29	6
7	22.25	15.22	5.22	6.44	16.44	22.44	22.39	16.32	6.12	5.24	16.13	22.36	7
8	22.17	15. 3	4.58	7. 7	17. 1	22.50	22.32	16.15	5.49	5.47	16.31	22.43	8
9	22. 9	14.44	4.35	7.29	17.17	22.55	22.25	15.58	5.26	6.10	16.49	22.49	9
10	22.00	14.25	4.11	7.51	17.33	23.00	22.18	15.41	5. 4	6.33	17. 6	22.55	10
11	21.51	14. 5	3.48	8.13	17.49	23. 5	22.10	15.23	4.41	6.56	17.22	23.00	11
12	21.41	13.45	3.24	8.35	18. 4	23. 9	22. 2	15. 5	4.18	7.18	17.39	23. 5	12
13	21.31	13.25	3. 1	8.57	18.19	23.13	21.54	14.47	3.55	7.41	17.55	23. 9	13
14	21.21	13. 5	2.37	9.19	18.34	23.16	21.45	14.29	3.32	8. 3	18.11	23.13	14
15	21.10	12.45	2.13	9.41	18.48	23.19	21.36	14.10	3. 9	8.26	18.27	23.17	15
16	20.59	12.24	1.50	10. 2	19. 2	23.21	21.27	13.51	2.46	8.48	18.42	23.20	16
17	20.47	12. 3	1.26	10.23	19.16	23.23	21.17	13.32	2.23	9.10	18.57	23.22	17
18	20.35	11.42	1. 2	10.44	19.30	23.25	21. 6	13.13	1.59	9.32	19.11	23.24	18
19	20.23	11.21	0.39	11. 5	19.43	23.26	20.56	12.54	1.36	9.54	19.26	23.26	19
20	20.10	10.59	0.15S	11.26	19.56	23.27	20.45	12.34	1.13	10.15	19.40	23.27	20
21	19.57	10.38	0. 9N	11.46	20. 8	23.28	20.34	12.14	0.49	10.37	19.53	23.27	21
22	19.44	10.16	0.32	12. 7	20.20	23.28	20.22	11.54	0.26	10.58	20. 6	23.28	22
23	19.30	9.54	0.56	12.27	20.32	23.27	20.10	11.34	0. 3N	11.19	20.19	23.27	23
24	19.16	9.32	1.20	12.47	20.43	23.26	19.58	11.14	0.21S	11.40	20.31	23.27	24
25	19. 1	9.10	1.43	13. 6	20.54	23.25	19.45	10.53	0.44	12. 1	20.44	23.25	25
26	18.46	8.48	2. 7	13.26	21. 5	23.24	19.32	10.32	1. 8	12.22	20.55	23.24	26
27	18.31	8.25	2.30	13.45	21.15	23.22	19.19	10.11	1.31	12.43	21. 6	23.21	27
28	18.15	8. 3	2.54	14. 4	21.25	23.19	19. 5	9.50	1.55	13. 3	21.17	23.19	28
29	17.59		3.17	14.23	21.35	23.16	18.51	9.29	2.18	13.23	21.28	23.15	29
30	17.43		3.40	14.41	21.44	23.13	18.37	9. 8	2.41	13.43	21.38	23.12	30
31	17.26		4. 4		21.53		18.22	8.46		14. 3		23. 8	31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1826,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1830, 1834.

DAYS.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	DAYS.
	Add to ap. tim	Add to ap. tim	Add to ap. tim	Add to ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Add to ap. tim	Add to ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	Sub. fr. ap. tim	
	M. S.	M. S.	M. S.	M. S	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	
1	3.50	13.56	12.41	4. 3	3. 3	2.40	3.17	5.58	0. 5	10.14	16.14	10.48	1
2	4.18	14. 4	12.29	3.44	3.11	2.30	3.29	5.55	0.23	10.33	16.15	10.25	2
3	4.46	14.10	12.16	3.26	3.18	2.21	3.40	5.51	0.42	10.51	16.16	10. 1	3
4	5.14	14.16	12. 3	3. 8	3.24	2.11	3.51	5.46	1. 1	11. 9	16.15	9.37	4
5	5.41	14.22	11.50	2.51	3.30	2. 1	4. 2	5.41	1.21	11.27	16.14	9.13	5
6	6. 8	14.26	11.36	2.33	3.35	1.51	4.13	5.35	1.40	11.45	16.11	8.47	6
7	6.34	14.30	11.21	2.16	3.40	1.40	4.23	5.28	2. 0	12. 2	16. 8	8.22	7
8	7.00	14.32	11. 7	1.59	3.44	1.29	4.33	5.21	2.20	12.19	16. 4	7.56	8
9	7.25	14.34	10.51	1.42	3.48	1.17	4.42	5.14	2.41	12.35	16. 0	7.29	9
10	7.50	14.36	10.36	1.25	3.51	1. 6	4.51	5. 5	3. 1	12.51	15.54	7. 2	10
11	8.14	14.36	10.20	1. 8	3.53	0.54	4.59	4.57	3.22	13. 7	15.48	6.34	11
12	8.38	14.36	10. 4	0.52	3.55	0.42	5. 8	4.47	3.43	13.22	15.41	6. 6	12
13	9. 1	14.35	9.48	0.36	3.56	0.29	5.15	4.37	4. 4	13.36	15.33	5.38	13
14	9.23	14.33	9.31	0.21	3.57	0.17	5.22	4.27	4.25	13.51	15.24	5.10	14
15	9.44	14.30	9.14	0. 6	3.57	0. 5	5.29	4.15	4.46	14. 4	15.14	4.41	15
16	10. 5	14.26	8.56	sub0.10	3.57	add0. 8	5.35	4. 4	5. 7	14.17	15. 4	4.12	16
17	10.26	14.22	8.39	0.24	3.56	0.21	5.40	3.52	5.28	14.30	14.52	3.43	17
18	10.45	14.17	8.21	0.38	3.55	0.34	5.46	3.39	5.49	14.41	14.40	3.13	18
19	11. 4	14.12	8. 3	0.52	3.53	0.46	5.50	3.26	6.10	14.53	14.27	2.43	19
20	11.22	14. 5	7.45	1. 6	3.50	0.59	5.54	3.12	6.31	15. 3	14.13	2.14	20
21	11.39	13.58	7.27	1.19	3.47	1.12	5.57	2.58	6.52	15.13	13.59	1.44	21
22	11.55	13.51	7. 8	1.31	3.44	1.25	6. 0	2.43	7.13	15.22	13.43	1.14	22
23	12.11	13.43	6.50	1.44	3.40	1.38	6. 3	2.28	7.34	15.31	13 27	0.44	23
24	12.26	13.34	6.31	1.55	3.35	1.51	6. 4	2.13	7.55	15.39	13. 9	0.15	24
25	12.40	13.24	6.13	2. 7	3.30	2. 3	6. 6	1.57	8.15	15.46	12.51	add0.17	25
26	12.53	13.14	5.54	2.17	3.24	2.16	6. 6	1.41	8.36	15.52	12.33	0.47	26
27	13. 5	13. 4	5.35	2.28	3.18	2.29	6. 6	1.24	8.56	15.58	12.13	1.17	27
28	13.17	12.52	5.17	2.37	3.11	2.41	6. 6	1. 7	9.16	16. 5	11.53	1.46	28
29	13.28		4.58	2.46	3. 4	2.53	6. 5	0.50	9.36	16. 7	11.32	2.16	29
30	13.38		4.39	2.55	2.56	3. 5	6. 3	0.32	9.55	16.10	11.10	2.45	30
31	13.47		4.21		2.48		6. 1	0.14		16.13		3.14	31

TABLE IV. THE SUN'S DECLINATION

FOR THE YEAR 1827,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1831, 1825.

DAYS.	Jan. South. ° '	Feb. South. ° '	March. South. ° '	April. North. ° '	May. North. ° '	June. North. ° '	July. North. ° '	Aug. North ° '	Sept. North. ° '	Oct. South. ° '	Nov. South ° '	Dec. South ° '	DAYS.
1	23. 3	17.14	7.45	4.21	14.56	22.00	23.10	18.11	8.29	2.59	14.17	21.45	1
2	22.58	16.57	7.23	4.45	15.14	22. 8	23. 6	17.56	8. 8	3.22	14.36	21.54	2
3	22.53	16.39	7.00	5. 8	15.32	22.16	23. 2	17.40	7.46	3.46	14.55	22. 3	3
4	22.47	16.21	6.37	5.31	15.49	22.23	22.57	17.25	7.24	4. 9	15.14	22.12	4
5	22.41	16. 3	6.14	5.53	16. 7	22.30	22.52	17. 9	7. 2	4.32	15.33	22.20	5
6	22.34	15.45	5.50	6.16	16.24	22.37	22.46	16.52	6.39	4.55	15.51	22.27	6
7	22.26	15.27	5.27	6.39	16.41	22.43	22.40	16.36	6.17	5.18	16. 9	22.35	7
8	22.19	15. 8	5. 4	7. 1	16.57	22.49	22.34	16.19	5.54	5.41	16.27	22.41	8
9	22.11	14.49	4.41	7.24	17.13	22.54	22.27	16. 2	5.32	6. 4	16.44	22.48	9
10	22. 2	14.30	4.17	7.46	17.29	22.59	22.20	15.45	5. 9	6.27	17. 1	22.53	10
11	21.53	14.10	3.54	8. 8	17.45	23. 4	22.12	15.27	4.46	6.50	17.18	22.59	11
12	21.44	13.50	3.30	8.30	18.00	23. 8	22. 4	15.10	4.24	7.13	17.35	23. 4	12
13	21.34	13.30	3. 6	8.52	18.16	23.12	21.56	14.51	4. 1	7.35	17.51	23. 8	13
14	21.23	13.10	2.43	9.14	18.30	23.15	21.47	14.33	3.38	7.58	18. 7	23.12	14
15	21.13	12.50	2.19	9.35	18.45	23.18	21.38	14.15	3.15	8.20	18.23	23.16	15
16	21. 2	12.29	1.56	9.57	18.59	23.21	21.29	13.56	2.51	8.42	18.38	23.19	16
17	20.50	12. 8	1.32	10.18	19.13	23.23	21.19	13.37	2.28	9. 4	18.53	23.22	17
18	20.38	11.47	1. 8	10.39	19.26	23.25	21. 9	13.18	2. 5	9.26	19. 8	23.24	18
19	20.26	11.26	0.44	11.00	19.40	23.26	20.58	12.58	1.42	9.48	19.22	23.25	19
20	20.13	11. 5	0.21S	11.21	19.53	23.27	20.47	12.39	1.18	10.10	19.36	23.27	20
21	20.00	10.43	0. 3N	11.41	20. 5	23.28	20.36	12.19	0.55	10.32	19.50	23.27	21
22	19.47	10.21	0.27	12. 2	20.17	23.28	20.25	11.59	0.32	10.53	20. 3	23.28	22
23	19.33	10.00	0.50	12.22	20.29	23.27	20.13	11.39	0. 8N	11.14	20.16	23.27	23
24	19.19	9.38	1.14	12.42	20.41	23.27	20.00	11.18	0.15S	11.35	20.28	23.27	24
25	19. 5	9.15	1.38	13. 2	20.52	23.25	19.48	10.58	0.39	11.56	20.41	23.26	25
26	18.50	8.53	2. 1	13.21	21. 3	23.24	19.35	10.37	1. 2	12.17	20.52	23.24	26
27	18.34	8.31	2.25	13.40	21.13	23.22	19.22	10.16	1.26	12.38	21. 4	23.22	27
28	18.19	8. 8	2.48	14.00	21.23	23.20	19. 8	9.55	1.49	12.58	21.15	23.19	28
29	18. 3		3.12	14.18	21.33	23.17	18.54	9.34	2.12	13.18	21.25	23.16	29
30	17.47		3.35	14.37	21.42	23.14	18.40	9.13	2.36	13.38	21.35	23.13	30
31	17.30		3.58		21.51		18.26	8.51		13.58		23. 9	31

TABLE IV. A.—THE EQUATION OF TIME

FOR THE YEAR 1827,

WHICH WILL ANSWER NEARLY FOR THE YEARS 1831, 1835.

DAYS.	Jan. Add to ap. tim M. S	Feb. Add to ap. tim M. S.	March. Add to ap. tim M. S.	April. Add to ap. tim M. S.	May. Sub. fr. ap. tim M. S.	June. Sub. fr. ap. tim M. S.	July. Add to ap. tim M. S.	Aug. Add to ap. tim M. S.	Sept. Add to ap. tim M. S.	Oct. Sub. fr. ap. tim M. S.	Nov. Sub. fr. ap. tim M. S.	Dec. Sub. fr. ap. tim M. S.	DAYS.
1	3.43	13.54	12.44	4. 9	2.59	2.39	3.17	6. 1	0. 1	10. 9	16.14	10.54	1
2	4.11	14. 2	12.32	3.50	3. 7	2.30	3.29	5.58	sub0.18	10.28	16.16	10.31	2
3	4.40	14. 9	12.20	3.32	3.14	2.20	3.40	5.53	0.37	10.47	16.16	10. 8	3
4	5. 7	14.15	12. 7	3.14	3.20	2.11	3.51	5.48	0.56	11. 5	16.16	9.44	4
5	5.34	14.21	11.54	2.56	3.26	2. 1	4. 2	5.43	1.16	11.23	16.15	9.20	5
6	6. 1	14.25	11.40	2.39	3.32	1.57	4.12	5.38	1.35	11.41	16.13	8.55	6
7	6.28	14.29	11.25	2.21	3.37	1.40	4.22	5.31	1.54	11.59	16.11	8.30	7
8	6.53	14.32	11.11	2. 4	3.41	1.29	4.32	5.24	2.16	12.16	16. 7	8. 3	8
9	7.19	14.34	10.56	1.47	3.45	1.18	4.41	5.16	2.36	12.32	16. 2	7.37	9
10	7.43	14.35	10.40	1.30	3.49	1. 7	4.50	5. 8	2.57	12.48	15.57	7.10	10
11	8. 8	14.35	10.24	1.13	3.51	0.55	4.59	4.59	3.17	13. 4	15.51	6.42	11
12	8.31	14.35	10. 8	0.57	3.53	0.43	5. 7	4.50	3.38	13.19	15.44	6.15	12
13	8.54	14.34	9.51	0.41	3.55	0.31	5.14	4.40	3.59	13.34	15.36	5.46	13
14	9.16	14.32	9.35	0.25	3.56	0.19	5.21	4.30	4.20	13.48	15.27	5.18	14
15	9.38	14.29	9.18	0. 9	3.57	0. 6	5.28	4.19	4.41	14. 1	15.18	4.49	15
16	9.59	14.26	9. 0	sub0. 6	3.56	add0. 6	5.34	4. 7	5. 2	14.14	15. 7	4.20	16
17	10.19	14.22	8.43	0.20	3.56	0.19	5.40	3.55	5.23	14.27	14.56	3.50	17
18	10.39	14.17	8.25	0.35	3.54	0.32	5.46	3.43	5.44	14.39	14.44	3.20	18
19	10.58	14.12	8. 7	0.49	3.52	0.45	5.50	3.30	6. 5	14.50	14.31	2.51	19
20	11.16	14. 6	7.49	1. 2	3.50	0.58	5.55	3.16	6.26	15. 0	14.17	2.21	20
21	11.33	13.59	7.31	1.15	3.47	1.11	5.58	3. 3	6.47	15,10	14. 2	1.51	21
22	11.50	13.52	7.13	1.27	3.43	1.24	6. 2	2.48	7. 7	15.20	13.47	1.20	22
23	12. 6	13.44	6.54	1.40	3.39	1.37	6. 4	2.33	7.28	15.28	13.30	0.50	23
24	12.21	13.36	6.36	1.51	3.34	1.50	6. 6	2.18	7.49	15.36	13.13	0.20	24
25	12.36	13.27	6.18	2. 2	3.29	2. 3	6. 8	2. 2	8. 9	15.44	12.56	add0.10	25
26	12.49	13.17	5.59	2.13	3.23	2.16	6. 9	1.46	8.30	15.50	12.37	0.40	26
27	13. 2	13. 7	5.41	2.25	3.17	2.29	6. 9	1.30	8.50	15.56	12.18	1.10	27
28	13.14	12.56	5.22	2.33	3.10	2.41	6. 9	1.13	9.10	16. 1	11.58	1.39	28
29	13.26		5. 4	2.42	3. 3	2.53	6. 8	0.55	9.30	16. 6	11.37	2. 9	29
30	13.36		4.45	2.51	2.55	3. 5	6. 6	0.38	9.49	16. 9	11.16	2.38	30
31	13.46		4.27		2.47		6. 4	0.20		16.12		3. 7	31

TABLE V.

For reducing the Sun's Declination as given in the Nautical Almanac for noon at Greenwich, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H.M 0. 20	H.M 0. 40	H.M 1. 0	H.M 1. 20	H.M 1. 40	H.M 2. 0	H.M 2. 20	H.M 2. 40	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	5 Deg.	10 Deg.	15 Deg.	20 Deg.	25 Deg.	30 Deg.	35 Deg.	40 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0 0	0. 1	0. 1	0. 1	0. 2	0. 2	0. 2	0. 3	22	20
19	23	0. 0	0. 1	0. 2	0. 2	0. 3	0. 4	0. 5	0. 6	23	19
18	24	0. 1	0. 2	0. 3	0. 4	0. 6	0. 7	0. 8	0. 9	24	18
17	25	0. 1	0. 3	0. 4	0. 6	0. 7	0. 9	0.11	0.12	25	17
16	26	0. 2	0 4	0. 5	0. 7	0. 9	0.11	0.13	0.15	26	16
15	27	0. 2	0. 5	0. 6	0. 8	0.11	0.13	0.15	0.18	27	15
14	28	0. 3	0. 6	0. 7	0.10	0.12	0.15	0.18	0.21	28	14
13	29	0. 3	0. 7	0. 9	0.12	0 15	0.18	0.21	0.24	29	13
12	30	0. 3	0. 7	0.10	0.13	0.17	0.20	0.23	0.27	30 June	12
11	Decemb. 31	0. 4	0. 8	0.11	0.15	0.19	0.22	0.26	0.30	1 July	11
10	January 1	0. 4	0. 8	0.12	0.16	0.20	0.24	0.28	0.32	2	10
9	2	0. 4	0. 8	0.13	0.17	0.21	0.26	0.30	0.35	3	9
8	3	0. 5	0. 9	0.14	0.19	0.24	0.29	0.33	0.38	4	8
7	4	0. 5	0.10	0.15	0.21	0.26	0.31	0.36	0.41	5	7
6	5	0. 5	0.11	0.16	0.22	0.28	0.33	0.38	0.44	6	6
5	6	0. 6	0.12	0.17	0.24	0.30	0.35	0.41	0.47	7	5
4	7	0. 6	0.12	0.18	0.25	0.31	0.37	0.43	0.49	8	4
3	8	0. 6	0.13	0.19	0.26	0.33	0.39	0.45	0.52	9	3
2	9	0. 7	0.14	0.20	0.27	0.34	0.41	0.48	0.55	10	2
Decemb. 1	10	0. 7	0.14	0.21	0.29	0.36	0.43	0.50	0.57	11	1 June
Novemb. 30	11	0. 7	0.15	0.22	0.30	0.37	0.45	0.52	1. 0	12	31 May
29	12	0. 8	0.16	0.23	0.31	0.39	0.47	0.55	1. 3	13	30
28	13	0. 8	0.16	0.24	0.33	0.41	0.49	0.57	1. 6	14	29
27	14	0. 8	0.17	0.25	0.34	0.42	0.51	0.59	1. 8	15	28
26	15	0. 9	0.18	0.26	0.35	0.44	0.53	1. 2	1.11	16	27
25	16	0. 9	0.18	0.27	0.37	0.46	0.55	1. 4	1.13	17	26
24	17	0. 9	0.19	0.28	0.38	0.47	0.57	1. 6	1.16	18	25
23	18	0.10	0.20	0.29	0.39	0.49	0.58	1. 9	1.19	19	24
22	19	0.10	0.20	0.30	0.40	0.50	1. 0	1.10	1.20	20	23
21	20	0.10	0.21	0.31	0.41	0.51	1. 2	1.12	1.22	21	22
20	21	0.11	0.22	0.32	0.43	0.53	1. 4	1.14	1.25	22	21
19	22	0.11	0.22	0.33	0.44	0.55	1. 6	1.17	1.28	23	20
18	23	0.11	0.23	0.34	0.45	0.56	1. 7	1.19	1.30	24	19
17	24	0.12	0.23	0.34	0.46	0.57	1. 9	1.21	1.32	25	18
16	25	0.12	0.24	0.35	0.47	0.59	1.11	1.23	1.35	26	17
15	26	0.12	0.24	0.36	0.48	1. 0	1.12	1.24	1.36	27	16
14	27	0.12	0.25	0.37	0.49	1. 2	1.14	1.26	1.39	28	15
13	28	0.13	0.26	0.38	0.51	1. 4	1.16	1.28	1.41	29	14
11	January 30	0.13	0.26	0.39	0.53	1. 6	1.19	1.32	1.45	31 July	12
9	February 1	0.13	0.27	0.41	0.55	1. 9	1.22	1.36	1.50	2 August	10
7	3	0.14	0.28	0.42	0.57	1.11	1.25	1.39	1.53	4	8
5	5	0.14	0.29	0.43	0.58	1.13	1.27	1.42	1.56	6	6
3	7	0.15	0.30	0.45	1. 0	1.15	1.30	1.44	1.59	8	4
Novemb. 1	9	0.15	0.31	0.46	1. 2	1.17	1.32	1.47	2. 3	10	2 May
October 30	11	0.16	0.32	0.47	1. 3	1.19	1.35	1.50	2. 6	12	30 April
28	13	0.16	0.32	0.48	1. 5	1.21	1.37	1.53	2. 9	14	28
26	15	0.16	0.33	0.49	1. 6	1.22	1.39	1.56	2.12	16	26
24	17	0.17	0.34	0.50	1. 7	1.24	1.41	1.58	2.15	18	24
21	20	0.17	0.34	0.52	1. 9	1.27	1.44	2. 1	2.19	21	21
18	23	0.17	0.35	0.53	1.11	1.29	1.46	2. 4	2.22	24	18
15	February 26	0.18	0.36	0.54	1.13	1.31	1.49	2. 7	2.25	27	15
12	March 1	0.18	0.37	0.55	1.14	1.32	1.51	2. 9	2.28	30 August	12
9	4	0.19	0.38	0.56	1.15	1.34	1.53	2.12	2.30	2 Sept.	9
6	7	0.19	0.38	0.57	1.16	1.35	1.54	2.13	2.32	5	6
October 3	10	0.19	0.38	0.57	1.17	1.36	1.55	2.14	2.34	8	3 April
Septemb. 30	13	0.19	0.39	0.58	1.17	1.37	1.56	2.15	2.35	11	31 March
27	16	0.19	0.39	0.58	1.18	1.38	1.57	2.16	2.36	14	28
24	19	0.20	0.39	0.58	1.18	1.38	1.57	2.16	2.36	17	25
After Equinox.	Before Equinox.	0.20	0.40	0.59	1.19	1.39	1.58	2.17	2.36	Before Equinox.	After Equinox.

TABLE V.

For reducing the SUN'S DECLINATION as given in the Nautical Almanac for noon at GREENWICH, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H.M 3. 0	H.M 3. 20	H.M 3. 40	H.M 4. 0	H.M 4. 20	H.M 4. 40	H.M 5. 0	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	45 Deg.	50 Deg.	55 Deg.	60 Deg.	65 Deg.	70 Deg.	75 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 3	0. 3	0. 4	0. 4	0. 4	0. 5	0. 5	22	20
19	23	0. 6	0. 7	0. 8	0. 9	0. 9	0.10	0.11	23	19
18	24	0.10	0.11	0.12	0.13	0.14	0.15	0.16	24	18
17	25	0.13	0.15	0.16	0.18	0.19	0.20	0.22	25	17
16	26	0.16	0.18	0.20	0.22	0.24	0.26	0.27	26	16
15	27	0.20	0.22	0.24	0.26	0.29	0.31	0.33	27	15
14	28	0.23	0.25	0.28	0.31	0.34	0.36	0.38	28	14
13	29	0.26	0.29	0.32	0.35	0.38	0.41	0.44	29	13
12	30	0.30	0.33	0.36	0.40	0.43	0.46	0.50	30 June	12
11	Decemb. 31	0.33	0.37	0.40	0.44	0.48	0.51	0.55	1 July	11
10	January 1	0.36	0.40	0.44	0.48	0.53	0.57	1. 1	2	10
9	2	0.39	0.44	0.48	0.53	0.57	1. 2	1. 6	3	9
8	3	0.43	0.48	0.53	0.57	1. 2	1. 7	1.11	4	8
7	4	0.46	0.51	0.56	1. 1	1. 7	1.12	1.17	5	7
6	5	0.49	0.55	1. 0	1. 6	1.11	1.17	1.22	6	6
5	6	0.52	0.58	1. 4	1.10	1.16	1.22	1.27	7	5
4	7	0.55	1. 1	1. 7	1.14	1.20	1.26	1.32	8	4
3	8	0.58	1. 5	1.11	1.18	1.24	1.31	1.37	9	3
2	9	1. 1	1. 8	1.15	1.22	1.29	1.36	1.43	10	2
Decemb. 1	10	1. 4	1.12	1.19	1.26	1.33	1.41	1.48	11	1 June
Novemb. 30	11	1. 7	1.15	1.23	1.30	1.37	1.45	1.52	12	31 May
29	12	1.10	1.18	1.26	1.34	1.42	1.50	1.57	13	30
28	13	1.13	1.22	1.30	1.38	1.46	1.54	2. 2	14	29
27	14	1.16	1.25	1.34	1.42	1.50	1.58	2. 7	15	28
26	15	1.19	1.28	1.37	1.46	1.55	2. 3	2.12	16	27
25	16	1.22	1.31	1.40	1.49	1.59	2. 8	2.17	17	26
24	17	1.25	1.35	1.44	1.53	2. 3	2.12	2.21	18	25
23	18	1.28	1.38	1.47	1.57	2. 7	2.16	2.26	19	24
22	19	1.30	1.41	1.51	2. 1	2.11	2.21	2.31	20	23
21	20	1.33	1.44	1.54	2. 4	2.15	2.25	2.35	21	22
20	21	1.36	1.47	1.57	2. 8	2.19	2.29	2.40	22	21
19	22	1.39	1.50	2. 0	2.11	2.22	2.33	2.44	23	20
18	23	1.41	1.53	2. 4	2.15	2.26	2.37	2.48	24	19
17	24	1.43	1.55	2. 7	2.18	2.30	2.41	2.52	25	18
16	25	1.46	1.58	2.10	2.21	2.33	2.45	2.56	26	17
15	26	1.48	2. 1	2.13	2.25	2.37	2.49	3. 1	27	16
14	27	1.51	2. 4	2.16	2.28	2.40	2.52	3. 5	28	15
13	28	1.54	2. 7	2.19	2.31	2.44	2.56	3. 9	29	14
11	January 30	1.58	2.11	2.24	2.37	2.51	3. 4	3.17	31 July	12
9	February 1	2. 3	2.17	2.30	2.43	2.57	3.11	3.24	2 August	10
7	3	2. 7	2.21	2.35	2.49	3. 3	3.17	3.32	4	8
5	5	2.11	2.25	2.40	2.54	3. 9	3.23	3.38	6	6
8	7	2.14	2.29	2.44	2.59	3.14	3.29	3.44	8	4
Novemb. 1	9	2.18	2.33	2.49	3. 4	3.19	3.35	3.50	10	2 May
October 30	11	2.22	2.38	2.53	3. 9	3.25	3.41	3.56	12	30 April
28	13	2.25	2.41	2.58	3.14	3.30	3.46	4. 3	14	28
26	15	2.29	2.45	3. 2	3.18	3.35	3.51	4. 8	16	26
24	17	2.32	2.49	3. 5	3.22	3.39	3.56	4.13	18	24
21	20	2.36	2.53	3.11	3.28	3.45	4. 3	4.20	21	21
18	23	2.40	2.58	3.15	3.33	3.51	4. 8	4.26	24	18
15	February 26	2.43	3. 1	3.20	3.38	3.56	4.14	4.32	27	15
12	March 1	2.46	3. 5	3.23	3.42	4. 1	4.19	4.38	30 August	12
9	4	2.49	3. 8	3.26	3.46	4. 4	4.23	4.41	2 Sept.	9
6	7	2.51	3.10	3.29	3.48	4. 7	4.26	4.45	5	6
October 3	10	2.53	3.13	3.32	3.51	4.10	4.29	4.49	8	3 April
Septemb. 30	13	2.55	3.14	3.33	3.53	4.13	4.32	4.51	11	31 March
27	16	2.56	3.15	3.34	3.54	4.14	4.33	4.52	14	28
24	19	2.56	3.15	3.35	3.55	4.15	4.33	4.52	17	25
After Equinox.	Before Equinox.	2.56	3.15	3.35	3.55	4.15	4.34	4.53	Before Equinox.	After Equinox.

TABLE V.

For reducing the Sun's Declination as given in the Nautical Almanac for noon at Greenwich, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H.M 5. 20	H.M 5. 40	H.M 6. 0	H.M 6. 20	H.M 6. 40	H.M 7. 0	H.M 7. 20	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	80 Deg.	85 Deg.	90 Deg.	95 Deg.	100 Deg.	105 Deg.	110 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 5	0. 6	0. 6	0. 7	0. 8	0. 8	0. 8	22	20
19	23	0.11	0.12	0.13	0.14	0.15	0.15	0.16	23	19
18	24	0.17	0.19	0.20	0.21	0.22	0.23	0.24	24	18
17	25	0.23	0.25	0.26	0.28	0.29	0.31	0.32	25	17
16	26	0.29	0.31	0.33	0.35	0.37	0.38	0.40	26	16
15	27	0.35	0.38	0.40	0.42	0.44	0.46	0.49	27	15
14	28	0.41	0.43	0.46	0.49	0.51	0.54	0.57	28	14
13	29	0.47	0.50	0.53	0.56	0.59	1. 2	1. 5	29	13
12	30	0.53	0.56	0.59	1. 3	1. 6	1. 9	1.12	30 June	12
11	Decemb. 31	0.59	1. 2	1. 6	1.10	1.13	1.17	1.21	1 July	11
10	January 1	1. 5	1. 9	1.13	1.17	1.21	1.25	1.29	2	10
9	2	1.11	1.15	1.19	1.24	1.28	1.32	1.37	3	9
8	3	1.16	1.21	1.26	1.31	1.35	1.40	1.45	4	8
7	4	1.22	1.27	1.32	1.37	1.42	1.47	1.53	5	7
6	5	1.27	1.33	1.38	1.44	1.49	1.54	2. 0	6	6
5	6	1.33	1.39	1.45	1.51	1.57	2. 2	2. 8	7	5
4	7	1.39	1.45	1 51	1.57	2. 3	2. 9	2.16	8	4
3	8	1.44	1.50	1.57	2. 4	2.10	2.16	2.23	9	3
2	9	1.50	1.56	2. 3	2.10	2.17	2.23	2.30	10	2
Decemb. 1	10	1.55	2. 2	2. 9	2.16	2.23	2.30	2.38	11	1 June.
Novemb. 30	11	2. 0	2. 7	2.15	2.22	2.30	2.37	2.45	12	31 May
29	12	2. 5	2.13	2.21	2.29	2.37	2.44	2.52	13	30
28	13	2.10	2.19	2.27	2.35	2.43	2.51	3. 0	14	29
27	14	2.16	2.25	2.33	2.42	2.50	2.58	3. 7	15	28
26	15	2.21	2.30	2.38	2.47	2.56	3. 5	3.13	16	27
25	16	2.26	2.35	2.44	2.53	3. 2	3.11	3.21	17	26
24	17	2.31	2.40	2.50	2.59	3. 9	3.18	3.28	18	25
23	18	2.36	2.46	2.55	3. 5	3.15	3.24	3.34	19	24
22	19	2.41	2.51	3. 1	3.11	3.21	3.31	3.41	20	23
21	20	2.46	2.56	3. 6	3.17	3.27	3.37	3.48	21	22
20	21	2.50	3. 2	3.12	3.23	3.33	3.44	3.55	22	21
19	22	2.55	3. 6	3.17	3.28	3.39	3.50	4. 1	23	20
18	23	3. 0	3.11	3.22	3.33	3.45	3.56	4. 7	24	19
17	24	3. 4	3.16	3.27	3.39	3.50	4. 1	4.13	25	18
16	25	3. 8	3.20	3.32	3.44	3.56	4. 7	4.19	26	17
15	26	3.13	3.25	3.37	3.49	4. 1	4.13	4.26	27	16
14	27	3.17	3.29	3.42	3.54	4. 6	4.19	4.31	28	15
13	28	3.22	3.34	3.47	4. 0	4.12	4.25	4.38	29	14
11	January 30	3.30	3.43	3.56	4. 9	4.22	4.36	4.49	31 July	12
9	February 1	3.38	3.51	4. 5	4.18	4.32	4.46	4.59	2 August	10
7	3	3.46	4. 0	4.14	4.28	4.42	4.56	5.10	4	8
5	5	3.52	4. 6	4.21	4.36	4.50	5. 5	5.19	6	6
3	7	3.59	4.14	4.29	4.44	4.59	5.14	5.29	8	4
Novemb. 1	9	4. 5	4.21	4.36	4.52	5. 7	5.23	5.38	10	2 May
October 30	11	4.12	4.28	4.44	5. 0	5.16	5.31	5.47	12	30 April
28	13	4.19	4.35	4.51	5. 7	5.23	5.40	5.56	14	28
26	15	4.24	4.41	4.57	5.14	5.30	5.47	6. 3	16	26
24	17	4.30	4.47	5. 3	5.21	5.38	5.55	6.12	18	24
21	20	4.37	4.55	5.12	5.29	5.47	6. 4	6.21	21	21
18	23	4.44	5. 2	5.19	5.37	5.55	6.13	6.31	24	18
15	February 26	4.50	5. 8	5.26	5.44	6. 2	6.20	6.38	27	15
12	March 1	4.56	5.15	5.33	5.52	6.10	6.29	6.47	30 August	12
9	4	5. 0	5.19	5.38	5.57	6.16	6.34	6.53	2 Sept.	9
6	7	5. 4	5.23	5.42	6. 1	6.20	6.39	6.58	5	6
October 3	10	5. 8	5.27	5.46	6. 5	6.25	6.44	7. 3	8	3 April
Septemb. 30	13	5.11	5.30	5.49	6. 8	6.28	6.47	7. 6	11	31 March
27	16	5.12	5.31	5.51	6.11	6.31	6.50	7. 9	14	28
24	19	5.12	5.32	5.52	6.12	6.32	6.51	7.11	17	25
After Equinox.	Before Equinox.	5.13	5.33	5.53	6.13	6.33	6.52	7.11	Before Equinox.	After Equinox.

TABLE V.

For reducing the SUN'S DECLINATION as given in the Nautical Almanac for noon at GREENWICH, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H.M 7. 40	H.M 8. 0	H.M 8. 20	H.M 8. 40	H.M 9. 0	H.M 9. 20	H.M 9. 40	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	115 Deg.	120 Deg.	125 Deg.	130 Deg.	135 Deg.	140 Deg.	145 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0. 9	0. 9	0. 9	0.10	0.10	0.10	0.10	22	20
19	23	0.17	0.18	0.18	0.19	0.19	0.20	0.21	23	19
18	24	0.25	0.26	0.27	0.28	0.29	0.30	0.31	24	18
17	25	0.34	0.35	0.36	0.38	0.39	0.41	0.43	25	17
16	26	0.42	0.44	0.46	0.48	0.49	0.51	0.53	26	16
15	27	0.51	0.53	0.55	0.57	0.59	1. 1	1. 3	27	15
14	28	0.59	1. 2	1. 5	1. 7	1. 9	1.12	1.14	28	14
13	29	1. 8	1.11	1.14	1.17	1.19	1.22	1.25	29	13
12	30	1.16	1.19	1.23	1.26	1.29	1.32	1.35	30 June	12
11	Decemb. 31	1.24	1.28	1.32	1.35	1.39	1.43	1.46	1 July	11
10	January 1	1.33	1.37	1.41	1.45	1.49	1.53	1.57	2	10
9	2	1.42	1.46	1.51	1.55	1.59	2. 3	2. 7	3	9
8	3	1.49	1.54	1.59	2. 4	2. 9	2.13	2.18	4	8
7	4	1.58	2. 3	2. 8	2.13	2.19	2.23	2.28	5	7
6	5	2. 5	2.11	2.16	2.22	2.28	2.33	2.39	6	6
5	6	2.14	2.20	2.26	2.32	2.38	2.43	2.49	7	5
4	7	2.22	2.28	2.34	2.41	2.47	2.53	2.59	8	4
3	8	2.29	2.36	2.43	2.49	2.56	3. 3	3. 9	9	3
2	9	2.37	2.44	2.51	2.58	3. 5	3.12	3.19	10	2
Decemb. 1	10	2.45	2.52	2.59	3. 6	3.14	3.21	3.28	11	1 June
Novemb. 30	11	2.52	3. 0	3. 7	3.15	3.23	3.30	3.38	12	31 May
29	12	3. 0	3. 8	3.16	3.24	3.32	3.39	3.47	13	30
28	13	3. 8	3.16	3.24	3.32	3.40	3.49	3.57	14	29
27	14	3.15	3.24	3.32	3.41	3.49	3.58	4. 6	15	28
26	15	3.22	3.31	3.40	3.49	3.58	4. 7	4.16	16	27
25	16	3.30	3.39	3.48	3.57	4. 7	4.16	4.25	17	26
24	17	3.37	3.46	3.56	4. 6	4.16	4.24	4.34	18	25
23	18	3.44	3.54	4. 4	4.14	4.24	4.33	4.43	19	24
22	19	3.51	4. 1	4.11	4.21	4.31	4.41	4.51	20	23
21	20	3.58	4. 8	4.19	4.29	4.39	4.50	5. 0	21	22
20	21	4. 5	4.16	4.27	4.37	4.48	4.59	5. 9	22	21
19	22	4.12	4.23	4.34	4.45	4.56	5. 7	5.18	23	20
18	23	4.19	4.30	4.41	4.53	5. 4	5.15	5.26	24	19
17	24	4.25	4.36	4.48	5. 0	5.12	5.23	5.34	25	18
16	25	4.31	4.43	4.55	5. 7	5.19	5.30	5.42	26	17
15	26	4.38	4.50	5. 2	5.14	5.26	5.38	5.50	27	16
14	27	4.43	4.56	5. 8	5.21	5.33	5.46	5.58	28	15
13	28	4.50	5. 3	5.16	5.28	5.40	5.54	6. 6	29	14
11	January 30	5. 2	5.15	5.28	5.41	5.54	6. 8	6.21	31 July	12
9	February 1	5.13	5.27	5.40	5.54	6. 8	6.22	6.35	2 August	10
7	3	5.24	5.38	5.52	6. 6	6.20	6.35	6.49	4	8
5	5	5.34	5.49	6. 4	6.18	6.33	6.47	7. 2	6	6
3	7	5.44	5.59	6.14	6.29	6.44	6.59	7.14	8	4
Novemb. 1	9	5.53	6. 9	6.24	6.40	6.55	7.11	7.26	10	2 May
October 30	11	6. 3	6.18	6.34	6.50	7. 6	7.21	7.37	12	30 April
28	13	6.12	6.28	6.44	7. 0	7.16	7.32	7.48	14	28
26	15	6.20	6.36	6.53	7.10	7.26	7.42	7.58	16	26
24	17	6.29	6.45	7. 2	7.19	7.36	7.52	8. 9	18	24
21	20	6.39	6.56	7.13	7.31	7.48	8. 5	8.22	21	21
18	23	6.48	7. 6	7.24	7.42	8. 0	8.17	8.34	24	18
15	February 26	6.57	7.15	7.34	7.52	8.10	8.28	8.46	27	15
12	March 1	7. 6	7.24	7.42	8. 1	8.20	8.38	8.57	30 August	12
9	4	7.12	7.31	7.50	8. 9	8.28	8.46	9. 6	2 Sept.	9
6	7	7.17	7.36	7.55	8.14	8.33	8.53	9.12	5	6
October 3	10	7.23	7.42	8. 1	8.20	8.39	8.59	9.18	8	3 April
Septemb. 30	13	7.26	7.45	8. 4	8.24	8.43	9. 3	9.22	11	31 March
27	16	7.29	7.48	8. 7	8.27	8.47	9. 6	9.25	14	28
24	19	7.30	7.50	8.10	8.29	8.49	9. 8	9.27	17	25
After Equinox.	Before Equinox.	7.31	7.50	8.10	8.30	8.50	9. 9	9.28	Before Equinox.	After Equinox.

TABLE V.

or reducing the Sun's Declination as given in the Nautical Almanac for noon at Greenwich, to any other Time under any other Meridian.

Add aft. N. Sub. bef. N.	Sub. aft. N. Add bef. N.	H. M. 10. 0	H. M. 10. 20	H. M. 10. 40	H. M. 11. 0	H. M. 11. 20	H. M. 11. 40	H. M. 12. 0	Sub. aft. N. Add bef. N.	Add aft. N. Sub. bef. N.
Add in W. Sub. in E.	Sub. in W. Add in E.	150 Deg.	155 Deg.	160 Deg.	165 Deg.	170 Deg.	175 Deg.	180 Deg.	Sub. in W. Add in E.	Add in W. Sub. in E.
Days.	Days.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	M. S.	Days.	Days.
Decemb. 21	Decemb. 21	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	21 June	21 June
20	22	0.11	0.11	0.12	0.12	0.12	0.13	0.13	22	20
19	23	0.22	0.23	0.24	0.24	0.25	0.26	0.26	23	19
18	24	0.33	0.34	0.35	0.36	0.37	0.38	0.39	24	18
17	25	0.44	0.46	0.47	0.48	0.50	0.51	0.53	25	17
16	26	0.55	0.57	0.58	1. 0	1. 2	1. 4	1. 6	26	16
15	27	1. 6	1. 8	1.11	1.13	1.15	1.17	1.19	27	15
14	28	1.17	1.20	1.23	1.25	1.27	1.30	1.32	28	14
13	29	1.28	1.31	1.34	1.37	1.40	1.43	1.46	29	13
12	30	1.39	1.42	1.45	1.49	1.52	1.56	1.59	30 June	12
11	Decemb. 31	1.50	1.54	1.57	2. 1	2. 5	2. 8	2.12	1 July	11
10	January 1	2. 1	2. 5	2. 9	2.13	2.17	2.21	2.25	2	10
9	2	2.12	2.16	2.20	2.25	2.30	2.34	2.38	3	9
8	3	2.23	2.27	2.32	2.37	2.42	2.47	2.51	4	8
7	4	2.34	2.39	2.44	2.49	2.54	2.59	3. 4	5	7
6	5	2.44	2.50	2.55	3. 0	3. 6	3.12	3.17	6	6
5	6	2.55	3. 1	3. 6	3.12	3.18	3.24	3.30	7	5
4	7	3. 5	3.11	3.17	3.23	3.29	3.36	3.42	8	4
3	8	3.15	3.21	3.28	3.34	3.41	3.48	3.54	9	3
2	9	3.25	3.32	3.38	3.45	3.52	3.59	4. 6	10	2
Decemb. 1	10	3.35	3.42	3.49	3.56	4. 4	4.11	4.18	11	1 June
Novemb. 30	11	3.45	3.52	3.59	4. 7	4.15	4.22	4.30	12	31 May
29	12	3.55	4. 3	4.10	4.18	4.26	4.34	4.42	13	30
28	13	4. 5	4.13	4.21	4.29	4.38	4.46	4.54	14	29
27	14	4.15	4.23	4.31	4.40	4.49	4.57	5. 5	15	28
26	15	4.24	4.33	4.41	4.50	4.59	5. 8	5.17	16	27
25	16	4.34	4.43	4.52	5. 1	5.10	5.19	5.28	17	26
24	17	4.43	4.53	5. 2	5.11	5.21	5.30	5.40	18	25
23	18	4.52	5. 2	5.12	5.22	5.32	5.41	5.51	19	24
22	19	5. 1	5.12	5.22	5.32	5.42	5.52	6. 2	20	23
21	20	5.10	5.21	5.31	5.42	5.53	6. 3	6.13	21	22
20	21	5.20	5.31	5.41	5.52	6. 3	6.14	6.24	22	21
19	22	5.29	5.40	5.51	6. 2	6.13	6.24	6.34	23	20
18	23	5.37	5.49	6. 0	6.11	6.23	6.34	6.44	24	19
17	24	5.45	5.57	6. 9	6.20	6.32	6.43	6.54	25	18
16	25	5.54	6. 6	6.17	6.29	6.41	6.53	7. 4	26	17
15	26	6. 2	6.14	6.26	6.38	6.51	7. 3	7.14	27	16
14	27	6.10	6.22	6.34	6.47	7. 0	7.12	7.24	28	15
13	28	6.19	6.31	6.43	6.56	7. 9	7.22	7.34	29	14
11	January 30	6.34	6.47	7. 0	7.13	7.26	7.40	7.53	31 July	12
9	February 1	6.49	7. 3	7.16	7.30	7.43	7.57	8.11	2 August	10
7	3	7. 3	7.17	7.31	7.45	7.59	8.13	8.28	4	8
5	5	7.16	7.31	7.45	8. 0	8.14	8.28	8.43	6	6
3	7	7.29	7.44	7.59	8.14	8.28	8.43	8.58	8	4
Novemb. 1	9	7.41	7.56	8.12	8.27	8.42	8.58	9.13	10	2 May
October 30	11	7.53	8. 8	8.24	8.40	8.56	9.12	9.28	12	30 April
28	13	8. 4	8.20	8.36	8.53	9. 9	9.25	9.42	14	28
26	15	8.15	8.32	8.48	9. 5	9.21	9.38	9.54	16	26
24	17	8.26	8.43	9. 0	9.17	9.34	9.50	10. 7	18	24
21	20	8.40	8.57	9.14	9.32	9.49	10. 6	10.24	21	21
18	23	8.52	9.10	9.28	9.46	10. 3	10.21	10.39	24	18
15	February 26	9. 4	9.22	9.40	9.58	10.16	10.34	10.53	27	15
12	March 1	9.15	9.33	9.51	10.10	10.29	10.47	11. 6	30 August	12
9	4	9.24	9.43	10. 1	10.20	10.39	10.58	11.16	2 Sept.	9
6	7	9 30	9.50	10. 9	10.28	10.47	11. 6	11.24	5	6
October 3	10	9.37	9.56	10.16	10.35	10.54	11.13	11.32	8	3 April
Septemb. 30	13	9.41	10. 0	10.21	10.40	10.59	11.18	11.38	11	31 March
27	16	9.45	10. 4	10.24	10.44	11. 3	11.22	11.42	14	28
24	19	9.47	10. 6	10.26	10.46	11. 5	11.24	11.44	17	25
After Equinox.	Before Equinox.	9.48	10. 7	10.27	10.47	11. 6	11.25	11.45	Before Equinox.	After Equinox.

TABLE VI.—SUN'S RIGHT ASCENSION.

Days.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Days.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	
1	18.45	20.58	22.48	0.42	2.33	4.35	6.40	8.44	10.41	12.29	14.25	16.29	1
2	18.50	21. 2	22.52	0.45	2.37	4.39	6.44	8.48	10.44	12.32	14.29	16.33	2
3	18.54	21. 6	22.55	0.49	2.40	4.44	6.48	8.52	10.48	12.36	14.33	16.37	3
4	18.59	21.10	22.59	0.52	2.44	4.48	6.52	8.56	10.51	12.40	14.37	16.42	4
5	19. 3	21.14	23. 3	0.56	2.48	4.52	6.56	9. 0	10.55	12.43	14.41	16.46	5
6	19. 7	21.18	23. 7	1. 0	2.52	4.56	7. 0	9. 4	10.59	12.47	14.45	16.50	6
7	19.12	21.22	23.10	1. 3	2.56	5. 0	7. 4	9. 8	11. 2	12.51	14.49	16.55	7
8	19.16	21.26	23.14	1. 7	3. 0	5. 4	7. 8	9.11	11. 6	12.54	14.53	16.59	8
9	19.21	21.30	23.18	1.11	3. 3	5. 8	7.13	9.15	11.10	12.58	14.57	17. 4	9
10	19.25	21.34	23.21	1.14	3. 7	5.12	7.17	9.19	11.13	13. 2	15. 1	17. 8	10
11	19.29	21.38	23.25	1.18	3.11	5.17	7.21	9.23	11.17	13. 5	15. 5	17.12	11
12	19.34	21.42	23.29	1.22	3.15	5.21	7.25	9.27	11.20	13. 9	15. 9	17.17	12
13	19.38	21.46	23.32	1.25	3.19	5.25	7.29	9.30	11.24	13.13	15.13	17.21	13
14	19.42	21.50	23.36	1.29	3.23	5.29	7.33	9.34	11.28	13.16	15.17	17.26	14
15	19.47	21.54	23.40	1.33	3.27	5.33	7.37	9.38	11.31	13.20	15 21	17.30	15
16	19.51	21.58	23.43	1.36	3.31	5.37	7.41	9.42	11.35	13.24	15.25	17.34	16
17	19.55	22. 1	23.47	1.40	3.35	5.41	7.45	9.45	11.38	13.28	15.29	17.39	17
18	19.59	22. 5	23.51	1.44	3.39	5.46	7.49	9.49	11.42	13.31	15.34	17.43	18
19	20. 4	22. 9	23.54	1.48	3.43	5.50	7.53	9.53	11.45	13.35	15.38	17.48	19
20	20. 8	22.13	23.58	1.51	3.47	5.54	7.57	9.57	11.49	13.39	15.42	17.52	20
21	20.12	22.17	0. 2	1.55	3.51	5.58	8. 1	10. 0	11.53	13.43	15.46	17.57	21
22	20.16	22.21	0. 5	1.59	3.55	6. 2	8. 5	10. 4	11.56	13.46	15.50	18. 1	22
23	20.21	22.24	0. 9	2. 2	3.59	6. 6	8. 9	10. 8	12. 0	13.50	15.55	18. 6	23
24	20.25	22.28	0.12	2. 6	4. 3	6.11	8.13	10.11	12. 3	13.54	15.59	18.10	24
25	20.29	22.32	0.16	2.10	4. 7	6.15	8.17	10.15	12. 7	13.58	16. 3	18.14	25
26	20.33	22.36	0.20	2.14	4.11	6.19	8.21	10.19	12.11	14. 2	16. 7	18.19	26
27	20.37	22.39	0.23	2.18	4.15	6.23	8.25	10.22	12.14	14. 6	16.11	18.23	27
28	20.41	22.43	0.27	2.21	4.19	6.27	8.29	10.26	12.18	14. 9	16.16	18.28	28
29	20.46	22.46	0.31	2.25	4.23	6.31	8.33	10.30	12.21	14.13	16.20	18.32	29
30	20.50		0.34	2.29	4.27	6.35	8 37	10.33	12.25	14.17	16.24	18.37	30
31	20.54		0.38	2.33	4.31		8.41	10.37		14.21		18.41	31

This Table gives nearly the mean of the Sun's Right Ascension for the years 1817, 1818, 1819, and 1820, and sufficiently exact for finding when any Star comes to the meridian. But in all calculations for determining t longitude by celestial observations, the Sun's Right Ascension must be taken from the Nautical Almanac, whe it is calculated to a greater degree of accuracy.

TABLE VI. A.

Correction for the daily variation of the Equation of Time found in Table IV. A.
Find the daily variation of Equation of Time at the top, the hour at Greenwich at the side.

Hour.	1″	2″	3″	4″	5″	6″	7″	8″	9″	10″	11″	12″	13″	14″	15″	16″	17″	18″	19″	20″	21″	22″	23″	24″	25″	26″	27″	28″	29″	30″	Deg.
1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
2	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3	30
3	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	45
4	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	60
5	0	0	1	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	4	4	4	5	5	5	5	5	6	6	6	6	75
6	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	90
7	0	1	1	1	1	2	2	2	3	3	3	4	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	8	9	105
8	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	120
9	0	1	1	2	2	2	3	3	3	4	4	5	5	5	6	6	6	7	7	8	8	8	9	9	9	10	10	11	11	11	135
10	0	1	1	2	2	3	3	3	4	4	5	5	5	6	6	7	7	8	8	8	9	9	10	10	10	11	11	12	12	13	150
11	0	1	1	2	2	3	3	4	4	5	5	6	6	6	7	7	8	8	9	9	10	10	11	11	11	12	12	13	13	14	165
12	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	180
13	1	1	2	2	3	3	4	4	5	5	6	7	7	8	8	9	9	10	10	11	11	12	12	13	14	14	15	15	16	16	195
14	1	1	2	2	3	4	4	5	5	6	6	7	8	8	9	9	10	11	11	12	12	13	13	14	15	15	16	16	17	18	210
15	1	1	2	3	3	4	4	5	6	6	7	8	8	9	9	10	11	11	12	13	13	14	14	15	16	16	17	18	18	19	225
16	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16	17	17	18	19	19	20	240
17	1	1	2	3	4	4	5	6	6	7	8	9	9	10	11	11	12	13	13	14	15	16	16	17	18	18	19	20	21	21	255
18	1	2	2	3	4	5	5	6	7	8	8	9	10	11	11	12	13	14	14	15	16	17	17	18	19	20	20	21	22	23	270
19	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13	13	14	15	16	17	17	18	19	20	21	21	22	23	24	285
20	1	2	3	3	4	5	6	7	8	8	9	10	11	12	13	13	14	15	16	17	18	18	19	20	21	22	23	23	24	25	300
21	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	18	19	20	21	22	23	24	25	25	26	315
22	1	2	3	4	5	6	6	7	8	9	10	11	12	13	14	15	16	17	17	18	19	20	21	22	23	24	25	26	27	28	330
23	1	2	3	4	5	6	7	8	9	10	11	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	345
24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	360

TABLE VII.

AMPLITUDES.

	DECLINATION IN DEGREES.																								
Lat.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.28	Lat.
	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	
1°	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	8. 0	9. 0	10. 0	11. 0	12. 0	13. 0	14. 0	15. 0	16. 0	17. 0	18. 0	19. 0	20. 0	21. 0	22. 0	23. 0	23.28	1°
2	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 0	8. 0	9. 0	10. 0	11. 0	12. 0	13. 0	14. 1	15. 1	16. 1	17. 1	18. 1	19. 1	20. 1	21. 1	22. 1	23. 1	23.29	2
3	1. 0	2. 0	3. 0	4. 0	5. 0	6. 0	7. 1	8. 1	9. 1	10. 1	11. 1	12. 1	13. 1	14. 1	15. 1	16. 1	17. 1	18. 2	19. 2	20. 2	21. 2	22. 2	23. 2	23.30	3
4	1. 0	2. 0	3. 0	4. 1	5. 1	6. 1	7. 1	8. 1	9. 1	10. 1	11. 2	12. 2	13. 2	14. 2	15. 2	16. 2	17. 3	18. 3	19. 3	20. 3	21. 3	22. 3	23. 4	23.32	4
5	1. 0	2. 0	3. 1	4. 1	5. 1	6. 1	7. 2	8. 2	9. 2	10. 2	11. 3	12. 3	13. 3	14. 3	15. 4	16. 4	17. 4	18. 4	19. 5	20. 5	21. 5	22. 5	23. 6	23.34	5
6	1. 0	2. 1	3. 1	4. 1	5. 2	6. 2	7. 2	8. 3	9. 3	10. 3	11. 4	12. 4	13. 4	14. 5	15. 5	16. 5	17. 6	18. 6	19. 7	20. 7	21. 7	22. 8	23. 8	23.36	6
7	1. 0	2. 1	3. 1	4. 2	5. 2	6. 3	7. 3	8. 4	9. 4	10. 5	11. 5	12. 5	13. 6	14. 6	15. 7	16. 7	17. 8	18. 8	19. 9	20. 9	21.10	22.10	23.11	23.39	7
8	1. 1	2. 1	3. 2	4. 2	5. 3	6. 4	7. 4	8. 5	9. 5	10. 6	11. 7	12. 7	13. 8	14. 8	15. 9	16.10	17.10	18.11	19.12	20.12	21.13	22.14	23.14	23.43	8
9	1. 1	2. 1	3. 2	4. 3	5. 4	6. 5	7. 5	8. 6	9. 7	10. 8	11. 8	12. 9	13.10	14.11	15.11	16.12	17.13	18.14	19.15	20.16	21.16	22.17	23.18	23.47	9
10	1. 1	2. 2	3. 3	4. 4	5. 5	6. 6	7. 7	8. 7	9. 8	10. 9	11.10	12.11	13.12	14.13	15.14	16.15	17.16	18.17	19.18	20.19	21.20	22.21	23.23	23.51	10
11	1. 1	2. 2	3. 3	4. 4	5. 6	6. 7	7. 8	8. 9	9.10	10.11	11.13	12.14	13.15	14.16	15.17	16.18	17.20	18.21	19.22	20.23	21.25	22.26	23.27	23.56	11
12	1. 1	2. 3	3. 4	4. 5	5. 7	6. 8	7. 9	8.11	9.12	10.14	11.15	12.16	13.18	14.19	15.21	16.22	17.24	18.25	19.26	20.28	21.30	22.31	23.33	24. 1	12
13	1. 2	2. 3	3. 5	4. 6	5. 8	6.10	7.11	8.13	9.14	10.16	11.18	12.19	13.21	14.23	15.24	16.26	17.28	18.29	19.31	20.33	21.35	22.37	23.38	24. 7	13
14	1. 2	2. 4	3. 6	4. 7	5. 9	6.11	7.13	8.15	9.17	10.19	11.20	12.22	13.24	14.26	15.28	16.30	17.32	18.34	19.36	20.38	21.40	22.43	23.45	24.14	14
15	1. 2	2. 4	3. 6	4. 8	5.11	6.13	7.15	8.17	9.19	10.21	11.24	12.26	13.28	14.30	15.33	16.35	17.37	18.39	19.42	20.44	21.47	22.49	23.52	24.21	15
16	1. 2	2. 5	3. 7	4.10	5.12	6.15	7.17	8.19	9.22	10.24	11.27	12.29	13.32	14.35	15.37	16.40	17.42	18.45	19.48	20.51	21.53	22.56	23.59	24.28	16
17	1. 3	2. 5	3. 8	4.11	5.14	6.17	7.19	8.22	9.25	10.28	11.31	12.33	13.36	14.39	15.42	16.45	17.48	18.51	19.54	20.57	22. 1	23. 4	24. 7	24.36	17
18	1. 3	2. 6	3. 9	4.12	5.15	6.19	7.22	8.25	9.28	10.31	11.34	12.38	13.41	14.44	15.47	16.51	17.54	18.58	20. 1	21. 5	22. 8	23.12	24.15	24.45	18
19	1. 3	2. 7	3.10	4.14	5.17	6.21	7.24	8.28	9.31	10.35	11.39	12.42	13.46	14.49	15.53	16.57	18. 1	19. 5	20. 8	21.12	22.16	23.20	24.25	24.54	19
20	1. 4	2. 8	3.12	4.15	5.19	6.23	7.27	8.31	9.35	10.39	11.43	12.47	13.51	14.55	15.59	17. 3	18. 8	19.12	20.16	21.21	22.25	23.30	24.34	25. 4	20
21	1. 4	2. 9	3.13	4.17	5.21	6.26	7.30	8.34	9.39	10.43	11.48	12.52	13.57	15. 1	16. 6	17.10	18.15	19.20	20.25	21.29	22.34	23.39	24.45	25.15	21
22	1. 5	2. 9	3.14	4.19	5.24	6.28	7.33	8.38	9.43	10.48	11.53	12.57	14. 2	15. 7	16.13	17.18	18.23	19.28	20.33	21.39	22.44	23.50	24.55	25.26	22
23	1. 5	2.10	3.16	4.21	5.26	6.31	7.36	8.42	9.47	10.52	11.58	13. 3	14. 9	15.14	16.20	17.25	18.31	19.37	20.43	21.49	22.55	24. 1	25. 7	25.38	23
24	1. 6	2.11	3.17	4.23	5.28	6.34	7.40	8.46	9.52	10.57	12. 3	13. 9	14.15	15.21	16.27	17.34	18.40	19.46	20.53	21.59	23. 6	24.13	25.19	25.51	24
25	1. 6	2.12	3.19	4.25	5.31	6.37	7.44	8.50	9.56	11. 3	12. 9	13.16	14.22	15.29	16.36	17.42	18.49	19.56	21. 3	22.10	23.18	24.25	25.32	26. 4	25
26	1. 7	2.14	3.20	4.27	5.34	6.41	7.48	8.54	10. 1	11. 8	12.15	13.22	14.30	15.37	16.44	17.52	18.59	20. 7	21.14	22.22	23.30	24.38	25.46	26.13	26
27	1. 7	2.15	3.22	4.29	5.37	6.44	7.52	8.59	10. 7	11.14	12.22	13.30	14.37	15.45	16.53	18. 1	19. 9	20.18	21.26	22.34	23.43	24.52	26. 1	26.33	27
28	1. 8	2.16	3.24	4.32	5.40	6.48	7.56	9. 4	10.12	11.21	12.29	13.37	14.46	15.54	17. 3	18.11	19.20	20.29	21.38	22.47	23.57	25. 6	26.16	26.43	28
29	1. 9	2.17	3.26	4.34	5.43	6.52	8. 1	9. 9	10.18	11.27	12.36	13.45	14.54	16. 3	17.13	18.22	19.32	20.41	21.51	23. 1	24.11	25.22	26.32	27. 5	29
30	1. 9	2.19	3.28	4.37	5.47	6.56	8. 5	9.15	10.24	11.34	12.44	13.53	15. 3	16.13	17.23	18.34	19.44	20.54	22. 5	23.16	24.27	25.38	26.49	27.23	30
31	1.10	2.20	3.30	4.40	5.50	7. 0	8.10	9.21	10.31	11.41	12.52	14. 2	15.13	16.24	17.34	18.45	19.57	21. 8	22.19	23.31	24.43	25.55	27. 7	27.41	31
32	1.11	2.22	3.32	4.43	5.54	7. 5	8.16	9.27	10.38	11.49	13. 0	14.11	15.23	16.34	17.46	18.58	20.10	21.22	22.35	23.47	25. 0	26.13	27.26	28. 0	32
33	1.12	2.23	3.35	4.46	5.58	7.10	8.21	9.33	10.45	11.57	13. 9	14.21	15.34	16.46	17.59	19.11	20.24	21.37	22.51	24. 4	25.18	26.32	27.46	28.21	33

AMPLITUDES.

DECLINATION IN DEGREES.

Lat.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23 28	Lat.
	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	D M	
34°	1.12	2.25	3.37	4.50	6. 2	7.15	8.27	9.40	10.53	12. 5	13.18	14.31	15.45	16.58	18.11	19.25	20.39	21.53	23. 7	24.22	25.37	26.52	28. 7	28.42	34°
35	1.13	2.27	3.40	4.53	6. 6	7.20	8.33	9.47	11. 1	12.14	13.28	14.42	15.56	17.11	18.25	19.40	20.55	22.10	23.25	24.41	25.57	27.13	28.29	29. 5	35
36	1.14	2.28	3.43	4.57	6.11	7.25	8.40	9.54	11. 9	12.24	13.39	14.54	16. 9	17.24	18.39	19.55	21.11	22.27	23.44	25. 1	26.18	27.35	28.53	29.29	36
37	1.15	2.30	3.45	5. 1	6.16	7.31	8.47	10. 2	11.18	12.33	13.49	15. 5	16.22	17.38	18.55	20.11	21.28	22.46	24. 3	25.21	26.40	27.58	29.17	29.55	37
38	1.16	2.32	3.48	5. 5	6.21	7.37	8.54	10.10	11.27	12.44	14. 1	15.18	16.35	17.53	19.10	20.28	21.47	23. 5	24.24	25.43	27. 3	28.23	29.44	30.21	38
39	1.17	2.34	3.52	5. 9	6.26	7.44	9. 1	10.19	11.37	12.55	14.13	15.31	16.50	18. 8	19.27	20.46	22. 6	23.26	24.46	26. 7	27.28	28.49	30.11	30.49	39
40	1.18	2.37	3.55	5.13	6.32	7.51	9. 9	10.28	11.47	13. 6	14.25	15.45	17. 5	18.25	19.45	21. 5	22.26	23.47	25. 9	26.31	27.54	29.17	30.40	31.19	40
41	1.20	2.39	3.59	5.18	6.38	7.58	9.18	10.38	11.58	13.18	14.39	15.59	17.20	18.42	20. 3	21.25	22.48	24.10	25.33	26.57	28.21	29.46	31.11	31.51	41
42	1.21	2.42	4. 2	5.23	6.44	8. 5	9.26	10.48	12. 9	13.31	14.53	16.15	17.37	19. 0	20.23	21.46	23.10	24.34	25.59	27.24	28.50	30.16	31.43	32.24	42
43	1.22	2.44	4. 6	5.28	6.51	8.13	9.36	10.58	12.21	13.44	15. 7	16.31	17.55	19.19	20.44	22. 8	23.34	25.00	26.26	27.53	29.20	30.49	32.18	32.59	43
44	1.23	2.47	4.10	5.34	6.58	8.21	9.45	11. 9	12.34	13.58	15.23	16.48	18.13	19.39	21. 5	22.32	23.59	25.26	26.55	28.23	29.53	31.23	32.54	33.37	44
45	1.25	2.50	4.15	5.40	7. 5	8.30	9.55	11.21	12.47	14.13	15.39	17. 6	18.33	20.00	21.28	22.57	24.25	25.55	27.25	28.56	30.27	31.59	33.33	34.16	45
46	1.26	2.53	4.19	5.46	7.12	8.39	10. 6	11.33	13. 1	14.29	15.57	17.25	18.54	20.23	21.53	23.23	24.53	26.25	27.57	29.30	31. 3	32.38	34.14	34.59	46
47	1.28	2.56	4.24	5.52	7.21	8.49	10.18	11.46	13.16	14.45	16.15	17.45	19.16	20.47	22.18	23.50	25.23	26.57	28.31	30. 6	31.42	33.19	34.57	35.43	47
48	1.30	2.59	4.29	5.59	7.29	8.59	10.30	12. 0	13.31	15. 2	16.34	18. 6	19.39	21.12	22.45	24.20	25.55	27.30	29. 7	30.44	32.23	34. 3	35.44	36.31	48
49	1.31	3. 3	4.35	6. 6	7.38	9.10	10.42	12.15	13.48	15.21	16.54	18.29	20. 3	21.38	23.14	24.51	26.28	28. 6	29.45	31.25	33. 7	34.49	36.33	37.22	49
50	1.33	3. 7	4.40	6.14	7.48	9.22	10.56	12.30	14. 5	15.40	17.16	18.52	20.29	22. 7	23.45	25.24	27. 3	28.44	30.26	32. 9	33.53	35.39	37.26	38.17	50
51	1.35	3.11	4.46	6.22	7.58	9.34	11.10	12.47	14.24	16. 1	17.39	19.17	20.57	22.36	24.17	25.59	27.41	29.25	31. 9	32.55	34.43	36.32	38.23	39.15	51
52	1.37	3.15	4.53	6.30	8. 8	9.47	11.25	13. 4	14.43	16.23	18. 3	19.44	21.26	23. 8	24.52	26.36	28.21	30. 8	31.56	33.45	35.36	37.29	39.24	40.18	52
53	1.40	3.19	4.59	6.39	8.20	10. 0	11.41	13.22	15. 4	16.46	18.29	20.13	21.57	23.42	25.28	27.16	29. 4	30.54	32.45	34.38	36.33	38.30	40.29	41.26	53
54	1.42	3.24	5. 7	6.49	8.32	10.15	11.58	13.42	15.26	17.11	18.57	20.43	22.30	24.18	26. 7	27.58	29.50	31.43	33.38	35.35	37.34	39.36	41.40	42.39	54
55	1.45	3.29	5.14	6.59	8.44	10.30	12.16	14. 3	15.50	17.37	19.26	21.15	23. 5	24.57	26.49	28.43	30.39	32.36	34.35	36.36	38.40	40.47	42.56	43.58	55
56	1.47	3.35	5.22	7.10	8.58	10.46	12.35	14.25	16.15	18. 5	19.57	21.50	23.43	25.38	27.34	29.32	31.31	33.33	35.36	37.42	39.51	42. 4	44.20	45.24	56
57	1.50	3.40	5.31	7.22	9.13	11. 4	12.56	14.48	16.42	18.36	20.30	22.26	24.24	26.22	28.22	30.24	32.28	34.34	36.43	38.54	41. 9	43.27	45.50	46.59	57
58	1.53	3.47	5.40	7.34	9.28	11.23	13.18	15.14	17.10	19. 8	21. 6	23. 6	25. 7	27.10	29.14	31.21	33.29	35.40	37.54	40.12	42.33	44.59	47.30	48.43	58
59	1.57	3.53	5.50	7.47	9.45	11.43	13.41	15.41	17.41	19.42	21.45	23.49	25.54	28. 1	30.10	32.21	34.35	36.52	39.12	41.37	44. 6	46.40	49.21	50.38	59
60	2. 0	4. 0	6. 0	8. 1	10. 2	12. 4	14. 6	16.10	18.14	20.19	22.26	24.34	26.44	28.56	31.10	33.27	35.47	38.10	40.38	43.10	45.47	48.31	51.24	52.47	60
61	2. 4	4. 8	6.12	8.16	10.21	12.27	14.34	16.41	18.49	20.59	23.11	25.24	27.39	29.56	32.16	34.39	37. 5	39.36	42.11	44.52	47.40	50.36	53.42	55.13	61
62	2. 8	4.16	6.24	8.33	10.42	12.52	15. 3	17.15	19.28	21.42	23.59	26.17	28.38	31. 1	33.27	35.57	38.31	41.10	43.54	46.46	49.46	52.56	56.20	58. 1	62
63	2.12	4.25	6.37	8.50	11. 4	13.19	15.34	17.51	20. 9	22.29	24.51	27.15	29.42	32.12	34.45	37.23	40. 5	42.54	45.49	48.53	52. 8	55.36	59.23	61.18	63
64	2.17	4.34	6.51	9. 9	11.28	13.48	16. 8	18.31	20.54	23.20	25.48	28.19	30.52	33.30	36.11	38.58	41.50	44.49	47.58	51.17	54.50	58.43	63. 2	65.17	64
65	2.22	4.44	7. 7	9.30	11.54	14.19	16.46	19.14	21.44	24.16	26.50	29.28	32.10	34.55	37.46	40.43	43.46	46.59	50.23	54. 2	57.59	62.25	67.36	70.26	65
66	2.28	4.55	7.24	9.53	12.22	14.54	17.26	20. 1	22.37	25.16	27.59	30.45	33.35	36.30	39.31	42.40	45.57	49.27	53.10	57.14	61.46	67. 4	73.52	78.15	66

Right Ascensions and Declinations of some of the principal fixed Stars, adapted to the beginning of the year 1820, with their annual variations.

Names and situations of the STARS.	Characters.	Magnitudes.	Right Ascension.	Ann. Var. R. A. add after 1820.	Declination.	Annual Variation.
			H.M.S.	"	° ′	"
Extremity of the wing of Pegasus, *Algenib*	γ	2	0. 3.59	3.08	14.11 N.	+20.1
In the head of the Phenix	α	2.3	0.17.22	2.99	43.16 S.	−20.0
Bright Star in the tail of the Whale	β	2.3	0.34.32	3.00	18.59 S.	−19.9
Polar Star, tail of the Little Bear	α	2.3	0.57. 1	14.26	88.21 N.	+19.4
In the girdle of Andromeda	β	2	0.59.40	3.30	34.40 N.	+19.5
The spring of the River Erida, *Achernar*	α	1	1.31. 0	2.25	58. 9 S.	−18.5
Almach in the foot of Andromeda	γ	2	1.52.53	3.62	41.28 N.	+17.7
*The following horn of the Ram, α ARIETIS	α	2	1.57. 8	3.35	22.36 N.	+17.4
In the neck of the Whale	σ	2	2.10.15	3.02	3.48 S.	−17.0
In the jaw of the Whale	α	2	2.52.52	3.12	3.23 N.	+14.8
In the head of Medusa, *Algol*	β	2	2.56.28	3.85	40.15 N.	+14.6
The bright Star in Perseus	α	2	3.11.31	4.20	49.13 N.	+13.6
The bright Star of the Pleiades, or Seven Stars	η	3	3.36.47	3.54	23.33 N.	+11.8
*The southern eye of the Bull, ALDEBARAN	α	1	4.25.36	3.43	16. 8 N.	+ 8.0
In the left shoulder of Auriga, *Capella*	α	1	5. 3.24	4.41	45.48 N.	+ 4.6
The bright foot of Orion, *Rigel*	β	1	5. 5.53	2.88	8.25 S.	− 4.9
The northern horn of the Bull	β	2	5.14.55	3.78	28.27 N.	+ 3.8
The western shoulder of Orion	γ	2	5.15.29	3.21	6.11 N.	+ 4.0
In the belt of Orion	δ	2	5.22.49	3.06	0.27 S.	− 3.3
	ε	2	5.27. 4	3.03	1.19 S.	− 3.0
	ζ	2	5.31.41	3.02	2. 3 S.	− 2.6
Bright Star in the Dove	α	2	5.33. 9	2.17	34.10 S.	− 2.4
The eastern shoulder of Orion	α	1	5.45.26	3.25	7.22 N.	+ 1.4
In the foot of the Great Dog	β	2.3	6.14.46	2.64	17.52 S.	+ 1.2
In the poop of the ship Argo *Canopus*	α	1	6.19.57	1.33	52.36 S.	+ 1.7
In the ankle of Pollux	γ	2.3	6.27.19	3.46	16.33 N.	− 2.3
In the mouth of the Greater Dog, *Sirius*	α	1	6.37.13	2.64	16.29 S.	+ 4.4
In the thigh of the Greater Dog	ε	2.3	6.51.32	2.35	28.44 S.	+ 4.4
In the back of the Greater Dog	δ	2.3	7. 1. 3	2.44	26. 7 S.	+ 5.2
In the tail of the Greater Dog	η	2	7.16.59	2.38	28.57 S.	+ 6.5
In the head of the northern Twin, *Castor*	α	1.2	7.23. 6	3.85	32.16 N.	− 7.1

Right Ascensions and Declinations of some of the principal fixed Stars, adapted to the beginning of the year 1820, with their annual variations.

Names & situations of the STARS.	Characters.	Magnitudes	Right Ascension.	Ann. Var. R. A. add after 1820.	Declination.	Annual Variation.
			H. M. S.	"	° ′	"
The Lesser Dog *Procyon*	α	1.2	7.29.52	3.15	5.41 N.	— 8.5
• In the head of the southern Twin, POLLUX	β	1.2	7.34.17	3.69	28.27 N.	— 8.0
In the row lock of the ship Argo	ξ	2	7.57.16	2.12	39.30 S.	+ 9.7
In the poop of the ship Argo	γ	2	8. 4. 1	1.86	46.48 S.	+10.3
In the middle of the ship Argo	δ	2.3	8.39.45	1.66	54. 3 S.	+12.9
In the oars of the ship Argo	β	2.3	9.11.13	0.75	68.59 S.	+14.9
The heart of the female Hydra, *Alphard*	α	2	9.18.44	2.95	7.53 S.	+15.2
• The Lion's heart REGULUS	α	1.2	9.58.46	3.21	12.51 N.	—17.3
South pointer in the sq. of the Great Bear	β	2	10.50.54	3.71	57.21 N.	—19.1
North pointer in the sq. of the Great Bear	α	1.2	10.52.32	3.83	62.48 N.	—19.3
The Lion's tail—*Denebola*	β	1.2	11.39.52	3.07	15.35 N.	—20.0
S. E. Star of □ of the Great Bear	γ	2	11.44.19	3.20	54.42 N.	—20.0
N. E. Star of □ of the Great Bear	δ	3	12. 6.27	3.02	58. 2 N.	—20.1
In the foot of the Cross	α	1	12.16.41	3.24	62. 6 S.	+20.0
In the top of the Cross	γ	2	12.21.13	3.24	56. 6 S.	+20.0
In the following arm of the Cross	β	2	12.37.18	3.41	58.41 S.	+19.8
Alioth, first star in the tail of the Great Bear	ε	2.3	12.46. 8	2.75	56.56 N.	—19.7
• The Virgin's spike—SPICA	α	1	13.15.43	3.14	10.13 S.	+19 0
The second Star in the tail of the Great Bear	ζ	2.3	13.16.39	2.43	55.52 N.	—19.0
Last Star in the tail of the Great Bear	η	2	13.40.26	2.38	50.13 N.	—18.2
The western foot of the Centaur	β	2	13.51.14	4.10	59.30 S.	+17.8
In the tail of the Dragon	α	2.3	13.59.31	1.63	65.14 N.	—17.1
The bright Star in Bootes—*Arcturus*	α	1	14. 7.26	2.73	20. 8 N.	—19.0
The eastern foot of the Centaur	α	1	14.28. 0	4.44	60. 7 S.	—16.1
The southern scale of the Balance	α	2.3	14.40.56	3.29	15.17 S.	+15.2
The northern scale of the Balance	β	2.3	15. 7.20	3.22	8.43 S.	+13.8
Bright Star in the crown *Gemma*	α	2	15.27. 4	2.53	27.20 N.	—12.5

L Tab.

TABLE VIII.

Right Ascensions and Declinations of some of the principal fixed Stars, adapted to the beginning of the year 1820, with their annual variations.

Names & situations of the STARS.	Characters.	Magnitudes.	Right Ascension.	Ann. Var. R. A. add. after 1820.	Declination.	Annual Variation.
			H. M. S.	"	° ′	"
In the neck of the Serpent	α	2	15.35.24	2.94	7. 0 N.	—11.7
The northernmost Star of the Scorpion's forehead	β	2	15.55. 0	3.47	19.18 S.	+10.5
* The Scorpion's heart, ANTARES	α	1	16.18.23	3.66	26. 1 S.	+ 8.6
In the eastern knee of Ophiuchus	η	2.3	17. 0. 3	3.42	15.30 S.	+ 5.3
In the head of Hercules	α	2	17. 6.27	2.73	14.36 N.	— 4.5
In the head of Ophiuchus	α	2	17.26.35	2.77	12.42 N.	— 3.1
In the head of the Dragon	γ	2.3	17.52.25	1.38	51.31 N.	— 0.7
In the bow of Sagittarius	ε	2.3	18.12.14	3.98	34.28 S.	— 0.9
The bright Star in the Harp, Wega, LYRA	α	1	18.30.51	2.03	38.37 N.	+ 3.0
* Bright Star in the Eagle, *Atair*, α AQUILÆ	α	1	19.42. 0	2.93	8.24 N.	+ 9.1
The eye of the Peacock	α	2	20.11.20	4.85	57.18 S.	—10.8
The tail of the Swan *Deneb*	α	1.2	20.35.18	2.04	44.39 N.	+12.6
The western wing of the Crane	α	2	21.56.49	3.85	47.49 S.	—17.4
* In the mouth of the southern fish, FOMALHAUT	α	1	22.47.41	3.34	30.34 S.	—19.1
In the shoulder of Pegasus	β	2	22.55. 3	2.87	27. 7 N.	+19.2
* In the wing of Pegasus, *Markab* α PEGASI	α	2	22.55.48	2.98	14.14 N.	+19.4
In the head of Andromeda	α	2	23.59. 6	3.08	28. 6 N.	+20.0
Near the shoulder of Cassiopea	β	2.3	23.59.35	3.05	58. 9 N.	+20.1

NOTE.—If the places of these stars are wanted for any time before the beginning of the year 1820, multiply the annual variation, in right ascension, by the number of years before 1820, and subtract the product from the right ascension standing in the table; but the product of the annual variation in declination by the number of years before 1820 must be added to, or subtracted from the declination, according as the sign — or + is marked in the Table; but for any years after 1820, the annual variation in right ascension multiplied by the number of years after 1820 must be added to the right ascension in the Table, and the annual variation in declination multiplied by the number of years after 1820 must be either added to, or subtracted from the declination, according to the signs in the Table.—The annual variation is set down for seconds and decimals of a second. An asterisk is prefixed to the stars whose distances from the moon are given in the Nautical Almanac. When very great accuracy is required, the corrections found in Tables XLII. and XLIII. for aberration and nutation, are to be applied to the numbers deduced from Table VIII. but these corrections are generally not of much importance in nautical calculations. The corrected values are however given in the Nautical Almanac for 24 of the bright stars of this catalogue for every ten days in the year, and these values are always to be preferred.

A TABLE shewing the time of the Sun's setting, when the latitude and declination are of the same name, and the time of its rising, when the latitude and declination are of different names.

DEGREES OF DECLINATION.

Lat.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.28	Lat.
	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	
1°	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	1°
2	6.00	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.03	6.03	6.03	2
3	6.00	6.00	6.00	6.01	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.03	6.04	6.04	6.04	6.04	6.05	6.05	6.05	6.05	3
4	6.00	6.00	6.01	6.01	6.01	6.01	6.02	6.02	6.02	6.03	6.03	6.03	6.03	6.04	6.04	6.04	6.05	6.05	6.05	6.06	6.06	6.06	6.06	6.07	6.07	4
5	6.00	6.00	6.01	6.01	6.01	6.02	6.02	6.02	6.03	6.03	6.04	6.04	6.04	6.05	6.05	6.05	6.06	6.06	6.07	6.07	6.07	6.08	6.08	6.09	6.09	5
6	6.00	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.03	6.04	6.04	6.05	6.05	6.06	6.06	6.06	6.07	6.07	6.08	6.08	6.09	6.09	6.10	6.10	6.10	6
7	6.00	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.04	6.04	6.05	6.05	6.06	6.06	6.07	6.08	6.08	6.09	6.09	6.10	6.10	6.11	6.11	6.12	6.12	7
8	6.00	6.01	6.01	6.02	6.02	6.03	6.03	6.04	6.05	6.05	6.06	6.06	6.07	6.07	6.08	6.09	6.09	6.10	6.10	6.11	6.12	6.12	6.13	6.14	6.14	8
9	6.00	6.01	6.01	6.02	6.03	6.03	6.04	6.04	6.05	6.06	6.06	6.07	6.08	6.08	6.09	6.10	6.10	6.11	6.12	6.13	6.13	6.14	6.15	6.15	6.16	9
10	6.00	6.01	6.01	6.02	6.03	6.04	6.04	6.05	6.06	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.12	6.13	6.14	6.15	6.16	6.16	6.17	6.18	10
11	6.00	6.01	6.02	6.02	6.03	6.04	6.05	6.05	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.13	6.14	6.14	6.15	6.16	6.17	6.18	6.19	6.19	11
12	6.00	6.01	6.02	6.03	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.18	6.19	6.20	6.21	6.21	12
13	6.00	6.01	6.02	6.03	6.04	6.05	6.06	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.18	6.19	6.20	6.21	6.22	6.23	13
14	6.00	6.01	6.02	6.03	6.04	6.05	6.06	6.07	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.17	6.19	6.20	6.21	6.22	6.23	6.24	6.25	14
15	6.00	6.01	6.02	6.03	6.04	6.05	6.06	6.08	6.09	6.10	6.11	6.12	6.13	6.14	6.15	6.16	6.18	6.19	6.20	6.21	6.22	6.24	6.25	6.26	6.27	15
16	6.00	6.01	6.02	6.03	6.05	6.06	6.07	6.08	6.09	6.10	6.12	6.13	6.14	6.15	6.16	6.18	6.19	6.20	6.21	6.23	6.24	6.25	6.27	6.28	6.29	16
17	6.00	6.01	6.02	6.04	6.05	6.06	6.07	6.09	6.10	6.11	6.12	6.14	6.15	6.16	6.17	6.19	6.20	6.21	6.23	6.24	6.26	6.27	6.28	6.30	6.31	17
18	6.00	6.01	6.03	6.04	6.05	6.07	6.08	6.09	6.10	6.12	6.13	6.14	6.16	6.17	6.19	6.20	6.21	6.23	6.24	6.26	6.27	6.29	6.30	6.32	6.32	18
19	6.00	6.01	6.03	6.04	6.06	6.07	6.08	6.10	6.11	6.13	6.14	6.15	6.17	6.18	6.20	6.21	6.23	6.24	6.26	6.27	6.29	6.30	6.32	6.34	6.34	19
20	6.00	6.01	6.03	6.04	6.06	6.07	6.09	6.10	6.12	6.13	6.15	6.16	6.18	6.19	6.21	6.22	6.24	6.26	6.27	6.29	6.30	6.32	6.34	6.36	6.36	20
21	6.00	6.02	6.03	6.05	6.06	6.08	6.09	6.11	6.12	6.14	6.16	6.17	6.19	6.20	6.22	6.24	6.25	6.27	6.29	6.30	6.32	6.34	6.36	6.38	6.38	21
22	6.00	6.02	6.03	6.05	6.06	6.08	6.10	6.11	6.13	6.15	6.16	6.18	6.20	6.21	6.23	6.25	6.27	6.28	6.30	6.32	6.34	6.36	6.38	6.39	6.40	22
23	6.00	6.02	6.03	6.05	6.07	6.09	6.10	6.12	6.14	6.15	6.17	6.19	6.21	6.22	6.24	6.26	6.28	6.30	6.32	6.34	6.36	6.38	6.39	6.42	6.42	23
24	6.00	6.02	6.04	6.05	6.07	6.09	6.11	6.13	6.14	6.16	6.18	6.20	6.22	6.24	6.25	6.27	6.29	6.31	6.33	6.35	6.37	6.39	6.41	6.44	6.45	24
25	6.00	6.02	6.04	6.06	6.07	6.09	6.11	6.13	6.15	6.17	6.19	6.21	6.23	6.25	6.27	6.29	6.31	6.33	6.35	6.37	6.39	6.41	6.43	6.46	6.47	25
26	6.00	6.02	6.04	6.06	6.08	6.10	6.12	6.14	6.16	6.18	6.20	6.22	6.24	6.26	6.28	6.30	6.32	6.34	6.36	6.39	6.41	6.43	6.45	6.48	6.49	26
27	6.00	6.02	6.04	6.06	6.08	6.10	6.12	6.14	6.16	6.19	6.21	6.23	6.25	6.27	6.29	6.31	6.34	6.36	6.38	6.40	6.43	6.45	6.48	6.50	6.51	27
28	6.00	6.02	6.04	6.06	6.09	6.11	6.13	6.15	6.17	6.19	6.22	6.24	6.26	6.28	6.30	6.33	6.35	6.37	6.40	6.42	6.45	6.47	6.50	6.52	6.53	28
29	6.00	6.02	6.04	6.07	6.09	6.11	6.13	6.16	6.18	6.20	6.22	6.25	6.27	6.29	6.32	6.34	6.37	6.39	6.42	6.44	6.47	6.49	6.52	6.54	6.56	29
30	6.00	6.02	6.05	6.07	6.09	6.12	6.14	6.16	6.19	6.21	6.23	6.26	6.28	6.31	6.33	6.36	6.38	6.41	6.43	6.46	6.49	6.51	6.54	6.57	6.58	30

A TABLE shewing the time of the Sun's setting, when the latitude and declination are of the same name, and the time of its rising, when the latitude and declination are of different names.

DEGREES OF DECLINATION.

Lat.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23.28	Lat.
	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	H M	
31°	6.00	6.02	6.05	6.07	6.10	6.12	6.14	6.17	6.19	6.22	6.24	6.27	6.29	6.32	6.34	6.37	6.40	6.42	6.45	6.48	6.51	6.53	6.56	6.59	7.00	31°
32	6.00	6.02	6.05	6.08	6.10	6.13	6.15	6.18	6.20	6.23	6.25	6.28	6.31	6.33	6.36	6.39	6.41	6.44	6.47	6.50	6.53	6.56	6.58	7.02	7.03	32
33	6.00	6.03	6.05	6.08	6.10	6.13	6.16	6.18	6.21	6.24	6.26	6.29	6.32	6.34	6.37	6.40	6.43	6.46	6.49	6.52	6.55	6.58	7.01	7.04	7.05	33
34	6.00	6.03	6.05	6.08	6.11	6.14	6.16	6.19	6.22	6.25	6.27	6.30	6.33	6.36	6.39	6.42	6.45	6.48	6.51	6.54	6.57	7.00	7.03	7.07	7.08	34
35	6.00	6.03	6.06	6.08	6.11	6.14	6.17	6.20	6.23	6.25	6.28	6.31	6.34	6.37	6.40	6.43	6.46	6.49	6.53	6.56	6.59	7.02	7.06	7.09	7.11	35
36	6.00	6.03	6.06	6.09	6.12	6.15	6.18	6.20	6.23	6.26	6.29	6.32	6.36	6.39	6.42	6.45	6.48	6.51	6.55	6.58	7.01	7.05	7.08	7.12	7.14	36
37	6.00	6.03	6.06	6.09	6.12	6.15	6.18	6.21	6.24	6.27	6.31	6.34	6.37	6.40	6.43	6.47	6.50	6.53	6.57	7.00	7.04	7.07	7.11	7.15	7.16	37
38	6.00	6.03	6.06	6.09	6.13	6.16	6.19	6.22	6.25	6.28	6.32	6.35	6.38	6.42	6.45	6.48	6.52	6.55	6.59	7.02	7.06	7.10	7.14	7.17	7.19	38
39	6.00	6.03	6.06	6.10	6.13	6.16	6.20	6.23	6.26	6.29	6.33	6.36	6.40	6.43	6.47	6.50	6.54	6.57	7.01	7.05	7.09	7.12	7.16	7.20	7.22	39
40	6.00	6.03	6.07	6.10	6.13	6.17	6.20	6.24	6.27	6.31	6.34	6.38	6.41	6.45	6.48	6.52	6.56	6.59	7.03	7.07	7.11	7.15	7.19	7.23	7.25	40
41	6.00	6.03	6.07	6.10	6.14	6.17	6.21	6.25	6.28	6.32	6.35	6.39	6.43	6.46	6.50	6.54	6.58	7.02	7.06	7.10	7.14	7.18	7.22	7.27	7.29	41
42	6.00	6.04	6.07	6.11	6.14	6.18	6.22	6.25	6.29	6.33	6.37	6.40	6.44	6.48	6.52	6.56	7.00	7.04	7.08	7.12	7.17	7.21	7.25	7.30	7.32	42
43	6.00	6.04	6.07	6.11	6.15	6.19	6.22	6.26	6.30	6.34	6.38	6.42	6.46	6.50	6.54	6.58	7.02	7.06	7.11	7.15	7.19	7.24	7.29	7.33	7.36	43
44	6.00	6.04	6.08	6.12	6.15	6.19	6.23	6.27	6.31	6.35	6.39	6.43	6.47	6.52	6.56	7.00	7.04	7.09	7.13	7.18	7.22	7.27	7.32	7.37	7.39	44
45	6.00	6.04	6.08	6.12	6.16	6.20	6.24	6.28	6.32	6.36	6.41	6.45	6.49	6.53	6.58	7.02	7.07	7.11	7.16	7.21	7.25	7.30	7.35	7.40	7.43	45
46	6.00	6.04	6.08	6.12	6.17	6.21	6.25	6.29	6.33	6.38	6.42	6.46	6.51	6.55	7.00	7.04	7.09	7.14	7.19	7.24	7.29	7.34	7.39	7.44	7.47	46
47	6.00	6.04	6.09	6.13	6.17	6.22	6.26	6.30	6.35	6.39	6.44	6.48	6.53	6.57	7.02	7.07	7.12	7.17	7.22	7.27	7.32	7.37	7.43	7.48	7.51	47
48	6.00	6.04	6.09	6.13	6.18	6.22	6.27	6.31	6.36	6.41	6.45	6.50	6.55	6.59	7.04	7.09	7.14	7.19	7.25	7.30	7.35	7.41	7.47	7.53	7.55	48
49	6.00	6.05	6.09	6.14	6.18	6.23	6.28	6.32	6.37	6.42	6.47	6.52	6.57	7.02	7.07	7.12	7.17	7.22	7.28	7.33	7.39	7.45	7.51	7.57	8.00	49
50	6.00	6.05	6.10	6.14	6.19	6.24	6.29	6.34	6.39	6.44	6.49	6.54	6.59	7.04	7.09	7.14	7.20	7.25	7.31	7.37	7.43	7.49	7.55	8.02	8.05	50
51	6.00	6.05	6.10	6.15	6.20	6.25	6.30	6.35	6.40	6.45	6.50	6.56	7.01	7.06	7.12	7.17	7.23	7.29	7.35	7.41	7.47	7.53	8.00	8.06	8.10	51
52	6.00	6.05	6.10	6.15	6.21	6.26	6.31	6.36	6.41	6.47	6.52	6.58	7.03	7.09	7.14	7.20	7.26	7.32	7.38	7.45	7.51	7.58	8.05	8.12	8.15	52
53	6.00	6.05	6.11	6.16	6.21	6.27	6.32	6.38	6.43	6.49	6.54	7.00	7.06	7.11	7.17	7.23	7.29	7.36	7.42	7.49	7.56	8.02	8.10	8.17	8.21	53
54	6.00	6.06	6.11	6.17	6.22	6.28	6.33	6.39	6.45	6.50	6.56	7.02	7.08	7.14	7.20	7.27	7.33	7.40	7.46	7.53	8.00	8.08	8.15	8.23	8.27	54
55	6.00	6.06	6.11	6.17	6.23	6.29	6.35	6.40	6.46	6.52	6.58	7.04	7.11	7.17	7.23	7.30	7.37	7.44	7.51	7.58	8.05	8.13	8.21	8.29	8.33	55
56	6.00	6.06	6.12	6.18	6.24	6.30	6.36	6.42	6.48	6.54	7.01	7.07	7.13	7.20	7.27	7.34	7.41	7.48	7.55	8.03	8.11	8.19	8.27	8.36	8.40	56
57	6.00	6.06	6.12	6.19	6.25	6.31	6.37	6.44	6.50	6.56	7.03	7.10	7.16	7.23	7.30	7.37	7.45	7.52	8.00	8.08	8.16	8.25	8.34	8.43	8.48	57
58	6.00	6.06	6.13	6.19	6.26	6.32	6.39	6.45	6.52	6.59	7.06	7.12	7.20	7.27	7.34	7.42	7.49	7.57	8.05	8.14	8.22	8.32	8.41	8.51	8.56	58
59	6.00	6.07	6.13	6.20	6.27	6.33	6.40	6.47	6.54	7.01	7.08	7.15	7.23	7.30	7.38	7.46	7.54	8.02	8.11	8.20	8.29	8.39	8.49	9.00	9.05	59
60	6.00	6.07	6.14	6.21	6.28	6.35	6.42	6.49	6.56	7.04	7.11	7.19	7.26	7.34	7.42	7.51	7.59	8.08	8.17	8.26	8.36	8.47	8.58	9.09	9.15	60

TABLE X.

For finding the Distance of Terrestrial Objects at Sea, in Statute miles.

Height in feet.	Distance. Mil. Dec.	Height in feet.	Distance. Mil. Dec.	Height in feet.	Distance. Mil. Dec.	Height in feet.	Distance. M.Tenths
1	1.32	44	8.78	320	23.67	1000	41.8
2	1.87	45	8.87	330	24.03	1100	43.9
3	2.29	46	8.97	340	24.39	1200	45.8
4	2.65	47	9.07	350	24.75	1300	47.7
5	2.96	48	9.17	360	25.10	1400	49.5
6	3.24	49	9.26	370	25.45	1500	51.2
7	3.50	50	9.35	380	25.79	1600	52.9
8	3.74	55	9.81	390	26.13	1700	54.5
9	3.97	60	10.25	400	26.46	1800	56.1
10	4.18	65	10.67	410	26.79	1900	57.7
11	4.39	70	11.07	420	27.11	2000	59.2
12	4.58	75	11.46	430	27.43	2100	60.6
13	4.77	80	11.83	440	27.75	2200	62.1
14	4.95	85	12.20	450	28.06	2300	63.4
15	5.12	90	12.55	460	28.37	2400	64.8
16	5.29	95	12.89	470	28.68	2500	66.1
17	5.45	100	13.23	480	28.98	2600	67.5
18	5.61	105	13.56	490	29.29	2700	68.7
19	5.77	110	13.88	500	29.58	2800	70.0
20	5.92	115	14.19	520	30.17	2900	71.2
21	6.06	120	14.49	540	30.74	3000	72.5
22	6.21	125	14.79	560	31.31	3100	73.7
23	6.34	130	15.08	580	31.86	3200	74.8
24	6.48	135	15.37	600	32.41	3300	76.0
25	6.61	140	15.65	620	32.94	3400	77.1
26	6.75	145	15.93	640	33.47	3500	78.3
27	6.87	150	16.20	660	33.99	3600	79.4
28	7.00	160	16.73	680	34.50	3700	80.5
29	7.12	170	17.25	700	35.00	3800	81.6
30	7.25	180	17.75	720	35.50	3900	82.6
31	7.37	190	18.24	740	35.99	4000	83.7
32	7.48	200	18.71	760	36.47	4100	84.7
33	7.60	210	19.17	780	36.95	4200	85.7
34	7.71	220	19.62	800	37.42	4300	86.8
35	7.83	230	20.06	820	37.88	4400	87.8
36	7.94	240	20.50	840	38.34	4500	88.7
37	8.05	250	20.92	860	38.80	4600	89.7
38	8.16	260	21.33	880	39.25	4700	90.7
39	8.26	270	21.74	900	39.69	4800	91.7
40	8.37	280	22.14	920	40.13	4900	92.6
41	8.47	290	22.53	940	40.56	5000	93.5
42	8.57	300	22.91	960	40.99	1 mile.	96.1
43	8.68	310	23.29	980	41.42		

TABLE XI.

eek the nearest number to the reduced time in the top column, and the difference of parallax, proportional logarithm, or semi-diameter for 12 hours in the side column; under the former and opposite the latter, is the correction to be applied to the number, marked first in the Nautical Almanac, additive if increasing, subtractive if decreasing.

REDUCED TIME.

Var. in 12 hrs.	h 0½	h 1	h 1½	h 2	h 2½	h 3	h 3½	h 4	h 4½	h 5	h 5½	h 6	h 6½	h 7	h 7½	h 8	h 8½	h 9	h 9½	h 10	h 10½	h 11	h 11½	h 12
	h 12½	h 13	h 13½	h 14	h 14½	h 15	h 15½	h 16	h 16½	h 17	h 17½	h 18	h 18½	h 19	h 19½	h 20	h 20½	h 21	h 21½	h 22	h 22½	h 23	h 23½	h 24
1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
3	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
4	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4
5	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5
6	0	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6
7	0	1	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7
8	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8
9	0	1	1	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	7	8	8	9	9
10	0	1	1	2	2	2	3	3	4	4	5	5	5	6	6	7	7	7	8	8	9	9	10	10
11	0	1	1	2	2	3	3	4	4	5	5	5	6	6	7	7	8	8	9	9	10	10	11	11
12	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12
13	1	1	2	2	3	3	4	4	5	5	6	6	7	8	8	9	9	10	10	11	11	12	12	13
14	1	1	2	2	3	3	4	5	5	6	6	7	8	8	9	9	10	10	11	12	12	13	13	14
15	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	11	11	12	12	13	14	14	15
16	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16
17	1	1	2	3	4	4	5	6	6	7	8	8	9	10	11	11	12	13	13	14	15	16	16	17
18	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	13	13	14	15	16	16	17	18
19	1	2	2	3	4	5	6	6	7	8	9	9	10	11	12	13	13	14	15	16	17	17	18	19
20	1	2	2	3	4	5	6	7	7	8	9	10	11	12	12	13	14	15	16	17	17	18	19	20
21	1	2	3	3	4	5	6	7	8	9	10	10	11	12	13	14	15	15	17	17	18	19	20	21
22	1	2	3	4	5	5	6	7	8	9	10	11	12	13	14	15	16	16	17	18	19	20	21	22
23	1	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23
24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
25	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	19	20	21	22	23	24	25
26	1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19	21	22	23	24	25	26
27	1	2	3	4	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22	24	25	26	27
28	1	2	3	5	6	7	8	9	10	12	13	14	15	16	17	19	20	21	22	23	24	26	27	28
29	1	2	4	5	6	7	8	10	11	12	13	14	16	17	18	19	21	22	23	24	25	27	28	29
30	1	2	4	5	6	7	9	10	11	12	14	15	16	17	19	20	21	22	24	25	26	27	29	30
31	1	3	4	5	6	8	9	10	12	13	14	15	17	18	19	21	22	23	25	26	27	28	30	31
32	1	3	4	5	7	8	9	11	12	13	15	16	17	19	20	21	23	24	25	27	28	29	31	32
33	1	3	4	5	7	8	10	11	12	14	15	16	18	19	21	22	23	25	26	27	29	30	32	33
34	1	3	4	6	7	8	10	11	13	14	16	17	18	20	21	23	24	25	27	28	30	31	33	34
35	1	3	4	6	7	9	10	12	13	15	16	17	19	20	22	23	25	26	28	29	31	32	34	35
36	1	3	4	6	7	9	10	12	13	15	16	18	19	21	22	24	25	27	28	30	31	33	34	36
37	2	3	5	6	8	9	11	12	14	15	17	18	20	22	23	25	26	28	29	31	32	34	35	37
38	2	3	5	6	8	9	11	13	14	16	17	19	21	22	24	25	27	28	30	32	33	35	36	38
39	2	3	5	6	8	10	11	13	15	16	18	19	21	23	24	26	28	29	31	32	34	36	37	39
40	2	3	5	7	8	10	12	13	15	17	18	20	22	23	25	27	28	30	32	33	35	37	38	40
41	2	3	5	7	9	10	12	14	15	17	19	20	22	24	26	27	29	31	32	34	36	38	39	41
42	2	3	5	7	9	10	12	14	16	17	19	21	23	24	26	28	30	31	33	35	37	38	40	42
43	2	4	5	7	9	11	13	14	16	18	20	21	23	25	27	29	30	32	34	36	38	39	41	43
44	2	4	5	7	9	11	13	15	16	18	20	22	24	26	27	29	31	33	35	37	38	40	42	44
45	2	4	6	7	9	11	13	15	17	19	21	22	24	26	28	30	32	34	36	37	39	41	43	45

TABLE XII. The Refraction of the Heavenly Bodies in Altitude.

App. Alt.	Ref.	App. Alt.	Ref.	App. Alt.	Ref.
D. M.	M. S.	D. M.	M. S.	D.	M. S.
0. 0	33. 0	6.30	7.52	30	1.38
0. 5	32.11	6.40	7.41	31	1.35
0.10	31.22	6.50	7.31	32	1.31
0.15	30.36	7. 0	7.21	33	1.28
0.20	29.50	7.10	7.12	34	1.24
0.25	29. 6	7.20	7. 3	35	1.21
0.30	28.23	7.30	6.54	36	1.18
0.35	27.41	7.40	6.46	37	1.16
0.40	27. 0	7.50	6.38	38	1.13
0.45	26.20	8. 0	6.30	39	1.10
0.50	25.42	8.10	6.22	40	1. 8
0.55	25. 5	8.20	6.15	41	1. 5
1. 0	24.29	8.30	6. 8	42	1. 3
1. 5	23.54	8.40	6. 1	43	1. 1
1.10	23.20	8.50	5.55	44	0.59
1.15	22.47	9. 0	5.49	45	0.57
1.20	22.15	9.10	5.43	46	0.55
1.25	21.44	9.20	5.37	47	0.53
1.30	21.15	9.30	5.31	48	0.51
1.35	20.46	9.40	5.26	49	0.50
1.40	20.18	9.50	5.20	50	0.48
1.45	19.51	10. 0	5.15	51	0.46
1.50	19.25	10.15	5. 8	52	0.45
1.55	18.59	10.30	5. 0	53	0.43
2. 0	18.35	10.45	4.54	54	0.41
2. 5	18.11	11. 0	4.47	55	0.40
2.10	17.48	11.15	4.41	56	0.38
2.15	17.26	11.30	4.35	57	0.37
2.20	17. 4	11.45	4.29	58	0.36
2.25	16.44	12. 0	4.23	59	0.34
2.30	16.23	12.20	4.16	60	0.33
2.35	16. 4	12.40	4. 9	61	0.32
2.40	15.45	13. 0	4. 3	62	0.30
2.45	15.27	13.20	3.57	63	0.29
2.50	15. 9	13.40	3.51	64	0.28
2.55	14.52	14. 0	3.46	65	0.27
3. 0	14.35	14.20	3.40	66	0.25
3. 5	14.19	14.40	3.35	67	0.24
3.10	14. 3	15. 0	3.30	68	0.23
3.15	13.48	15.30	3.23	69	0.22
3.20	13.33	16. 0	3.17	70	0.21
3.25	13.19	16.30	3.11	71	0.20
3.30	13. 5	17. 0	3. 5	72	0.19
3.40	12.39	17.30	2.59	73	0.17
3.50	12.14	18. 0	2.54	74	0.16
4. 0	11.50	18.30	2.49	75	0.15
4.10	11.28	19. 0	2.44	76	0.14
4.20	11. 7	19.30	2.40	77	0.13
4.30	10.47	20. 0	2.36	78	0.12
4.40	10.28	20.30	2.32	79	0.11
4.50	10.10	21. 0	2.28	80	0.10
5. 0	9.53	21.30	2.24	81	0. 9
5.10	9.37	22. 0	2.20	82	0. 8
5.20	9.21	23. 0	2.14	83	0. 7
5.30	9. 7	24. 0	2. 7	84	0. 6
5.40	8.53	25. 0	2. 2	85	0. 5
5.50	8.39	26. 0	1.56	86	0. 4
6. 0	8.27	27. 0	1.51	87	0. 3
6.10	8.15	28. 0	1.47	88	0. 2
6.20	8. 3	29. 0	1.43	89	0. 1

TABLE XIII. Depression or Dip of the Horizon of the sea.

Height of the eye.	Dip of the Horizon.
Feet.	M. S.
1	0.59
2	1.24
3	1.42
4	1.58
5	2.12
6	2.25
7	2.36
8	2.47
9	2.57
10	3. 7
11	3.16
12	3.25
13	3.33
14	3.41
15	3.49
16	3.56
17	4. 3
18	4.11
19	4.17
20	4.24
21	4.31
22	4.37
23	4.43
24	4.49
26	5. 1
28	5.13
30	5.23
35	5.49
40	6.14
45	6.36
50	6.58
60	7.37
70	8.14
80	8.48
90	9.20
100	9.51

TABLE XIV. The Sun's Parallax in Altitude.

Sun's Alt.	Sun's Parallax.
D.	S.
0	9
10	9
20	8
30	8
40	7
50	6
55	5
60	4
65	4
70	3
75	2
80	2
85	1
90	0

TABLE XV. Augmentation of the Moon's Semi-diameter.

Moon's Alt.	Augmentation.
D.	S.
0	0
5	1
10	3
15	4
20	5
25	7
30	8
35	9
40	10
45	11
50	12
55	13
60	14
70	15
80	15
90	16

TABLE XVI Dip of the Sea at different Distances from the Observer.

Dist. of the land in Sea miles.	Height of the Eye above the Sea in Feet.							
	5	10	15	20	25	30	35	40
	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.	Dip.
	M.	M.	M.	M.	M.	M.	M.	M.
1/4	11	23	34	45	57	68	79	91
1/2	6	12	17	23	28	34	40	45
3/4	4	8	12	15	19	23	27	30
1	3	6	9	12	15	17	20	23
1 1/4	3	5	7	10	12	14	16	19
1 1/2	3	4	6	8	10	12	14	16
2	2	4	5	7	8	9	11	12
2 1/2	2	3	4	6	7	8	9	10
3	2	3	4	5	6	7	8	9
3 1/2	2	3	4	5	6	6	7	8
4	2	3	4	5	5	6	7	7
5	2	3	4	4	5	6	6	7
6	2	3	4	4	5	5	6	6

NOTE TO TABLE XVI.—The numbers of this table below the black lines, are the same as are given in Table XIII. the visible horizon, corresponding to those heights, not being so far distant as the land.

TABLE XVII.

WHEN A STAR IS USED.

*Ap. Alt. D M	Cor. M S	Log.	*Ap. Alt. D M	Cor. M S	Log.	*Ap. Alt. D M	Cor. M S	Log.	*Ap. Alt. D M	Cor. M S	Log.	*Ap. Alt. D M	Cor. M S	Log.
5. 0	50. 8	0.9581	10. 0	54.45	1.2277	13.15	56. 2	1.3433	19. 0	57.16	1.4925	36.30	58.43	1.7517
10	50.24	0.9700	3	54.47	1.2297	20	56. 3	1.3459	10	57.17	1.4960	37. 0	58.45	1.7568
20	50.39	0.9817	6	54.48	1.2317	25	56. 5	1.3485	20	57.19	1.4996	30	58.46	1.7618
30	50.54	0.9930	9	54.50	1.2337	30	56. 6	1.3511	30	57.20	1.5031	38. 0	58.47	1.7668
40	51. 8	1.0041	12	54.51	1.2357	35	56. 8	1.3537	40	57.22	1.5066	30	58.49	1.7717
50	51.21	1.0150	15	54.53	1.2377	40	56. 9	1.3562	50	57.23	1.5101	39. 0	58.50	1.7766
6. 0	51.34	1.0255	10.18	54.54	1.2397	13.45	56.10	1.3587	20. 0	57.25	1.5136	39.30	58.51	1.7810
10	51.46	1.0360	21	54.56	1.2417	50	56.12	1.3612	10	57.26	1.5170	40. 0	58.52	1.7854
20	51.57	1.0462	24	54.57	1.2437	55	56.13	1.3637	20	57.27	1.5204	30	58.53	1.7900
30	52. 9	1.0562	27	54.58	1.2457	14. 0	56.15	1.3662	30	57.29	1.5238	41. 0	58.55	1.7946
40	52.19	1.0660	30	55. 0	1.2476	5	56.16	1.3687	40	57.30	1.5271	30	58.56	1.7987
50	52.29	1.0755	33	55. 1	1.2496	10	56.17	1.3711	50	57.31	1.5304	42. 0	58.57	1.8028
7. 0	52.39	1.0849	10.36	55. 3	1.2515	14.15	56.19	1.3735	21. 0	57.33	1.5338	42.30	58.58	1.8070
10	52.49	1.0941	39	55. 4	1.2534	20	56.20	1.3759	10	57.34	1.5370	43. 0	58.59	1.8112
20	52.58	1.1032	42	55. 5	1.2553	25	56.21	1.3783	20	57.35	1.5401	30	59. 0	1.8152
30	53. 6	1.1120	45	55. 7	1.2572	30	56.22	1.3807	30	57.36	1.5432	44. 0	59. 1	1.8192
35	53.11	1.1164	48	55. 8	1.2591	35	56.24	1.3831	40	57.37	1.5463	30	59. 2	1.8230
40	53.15	1.1207	51	55. 9	1.2610	40	56.25	1.3855	50	57.39	1.5494	45. 0	59. 3	1.8268
7.45	53.19	1.1250	10.54	55.11	1.2629	14.45	56.26	1.3878	22. 0	57.40	1.5525	46.	59. 5	1.8338
48	53.21	1.1275	57	55.12	1.2648	50	56.28	1.3901	10	57.41	1.5556	47.	59. 7	1.8411
51	53.24	1.1301	11. 0	55.13	1.2667	55	56.29	1.3924	20	57.42	1.5586	48.	59. 9	1.8478
54	53.26	1.1326	3	55.14	1.2686	15. 0	56.30	1.3947	30	57.43	1.5616	49.	59.11	1.8547
57	53.28	1.1351	6	55.16	1.2705	5	56.31	1.3970	40	57.44	1.5646	50.	59.12	1.8611
8. 0	53.30	1.1376	9	55.17	1.2724	10	56.32	1.3993	50	57.45	1.5676	51.	59.14	1.8676
8. 3	53.33	1.1401	11.12	55.18	1.2742	15.15	56.33	1.4016	23. 0	57.46	1.5706	52.	59.16	1.8734
6	53.35	1.1425	15	55.19	1.2760	20	56.34	1.4039	10	57.47	1.5736	53.	59.17	1.8794
9	53.37	1.1450	18	55.21	1.2778	25	56.36	1.4061	20	57.49	1.5765	54.	59.19	1.8846
12	53.39	1.1474	21	55.22	1.2796	30	56.37	1.4083	30	57.50	1.5794	55.	59.20	1.8900
15	53.42	1.1499	24	55.23	1.2814	35	56.38	1.4105	40	57.51	1.5822	56.	59.22	1.8956
18	53.44	1.1523	27	55.24	1.2832	40	56.39	1.4127	50	57.52	1.5850	57.	59.23	1.9003
8.21	53.46	1.1547	11.30	55.25	1.2850	15.45	56.40	1.4149	24. 0	57.53	1.5879	58.	59.24	1.9050
24	53.48	1.1571	33	55.27	1.2868	50	56.41	1.4171	10	57.54	1.5907	59.	59.26	1.9102
27	53.50	1.1595	36	55.28	1.2886	55	56.42	1.4193	20	57.55	1.5935	60.	59.27	1.9142
30	53.52	1.1619	39	55.29	1.2904	16. 0	56.43	1.4214	30	57.56	1.5963	61.	59.28	1.9183
33	53.54	1.1642	42	55.30	1.2922	5	56.44	1.4236	40	57.56	1.5990	62.	59.30	1.9226
36	53.56	1.1666	45	55.31	1.2940	10	56.45	1.4258	50	57.57	1.6017	63.	59.31	1.9270
8.39	53.58	1.1689	11.48	55.32	1.2957	16.15	56.46	1.4279	25. 0	57.58	1.6044	64.	59.32	1.9302
42	54. 0	1.1712	51	55.34	1.2974	20	56.47	1.4300	20	58. 0	1.6097	65.	59.33	1.9335
45	54. 2	1.1735	54	55.35	1.2991	25	56.48	1.4321	40	58. 2	1.6149	66.	59.35	1.9369
48	54. 4	1.1758	57	55.36	1.3008	30	56.49	1.4342	26.00	58. 4	1.6201	67.	59.36	1.9404
51	54. 6	1.1781	12. 0	55.37	1.3025	35	56.50	1.4363	20	58. 5	1.6251	68.	59.37	1.9438
54	54.08	1.1804	3	55.38	1.3042	40	56.51	1.4384	40	58. 7	1.6301	69.	59.38	1.9471
8.57	54.10	1.1826	12. 6	55.39	1.3059	16.45	56.52	1.4405	27. 0	58. 9	1.6350	70.	59.39	1.9501
9. 0	54.12	1.1849	9	55.40	1.3076	50	56.53	1.4425	20	58.10	1.6400	71.	59.40	1.9528
3	54.13	1.1871	12	55.41	1.3093	55	56.54	1.4445	40	58.12	1.6449	72.	59.42	1.9553
6	54.15	1.1893	15	55.42	1.3110	17. 0	56.55	1.4465	28. 0	58.13	1.6498	73.	59.43	1.9578
9	54.17	1.1916	18	55.43	1.3127	5	56.56	1.4486	20	58.15	1.6545	74.	59.44	1.9603
12	54.19	1.1938	21	55.44	1.3144	10	56.57	1.4506	40	58.16	1.6591	75.	59.45	1.9625
9.15	54.21	1.1960	12.24	55.45	1.3161	17.15	56.58	1.4526	29. 0	58.18	1.6635	76.	59.46	1.9643
18	54.22	1.1982	27	55.46	1.3178	20	56.59	1.4546	30	58.20	1.6702	77.	59.47	1.9660
21	54.24	1.2003	30	55.47	1.3194	25	57. 0	1.4566	30. 0	58.22	1.6769	78.	59.48	1.9676
24	54.26	1.2025	33	55.48	1.3211	30	57. 1	1.4586	30	58.24	1.6833	79.	59.49	1.9692
27	54.28	1.2047	36	55.49	1.3227	35	57. 2	1.4606	31. 0	58.25	1.6896	80.	59.50	1.9706
30	54.29	1.2068	39	55.50	1.3243	40	57. 3	1.4626	30	58.27	1.6957	81.	59.51	1.9714
9.33	54.31	1.2089	12.42	55.51	1.3259	17.45	57. 4	1.4646	32. 0	58.29	1.7018	82.	59.52	1.9722
36	54.33	1.2110	45	55.52	1.3275	50	57. 4	1.4665	30	58.31	1.7079	83.	59.53	1.9729
39	54.34	1.2132	48	55.53	1.3291	55	57. 5	1.4684	33. 0	58.33	1.7140	84.	59.54	1.9734
42	54.36	1.2153	51	55.54	1.3307	18. 0	57. 6	1.4703	30	58.34	1.7202	85.	59.55	1.9737
45	54.37	1.2173	54	55.55	1.3323	10	57. 8	1.4741	34. 0	58.36	1.7262	86.	59.56	1.9739
48	54.39	1.2194	57	55.56	1.3339	20	57. 9	1.4778	30	58.37	1.7312	87.	59.57	1.9741
9.51	54.41	1.2215	13. 0	55.57	1.3355	18.30	57.11	1.4815	35. 0	58.39	1.7362	88.	59.58	1.9742
54	54.42	1.2236	5	55.59	1.3381	40	57.13	1.4852	30	58.40	1.7414	89.	59.59	1.9742
57	54.44	1.2257	10	56. 0	1.3407	50	57.14	1.4888	36. 0	58.42	1.7466	90.	60. 0	1.9742

WHEN THE SUN IS USED.

⊙Ap. Alt. D M	Cor. M S	Log.	⊙Ap. Alt. D M	Cor. M S	Log.	⊙Ap. Alt. D M	Cor. M S	Log.	⊙Ap. Alt. D M	Cor. M S	Log.	⊙Ap. Alt. D M	Cor. M S	Log.
5. 0	50.16	0.9645	10. 0	54.54	1.2397	13.15	56.10	1.3592	19. 0	57.24	1.5149	36.30	58.50	1.7934
10	50.32	0.9766	3	54.55	1.2418	20	56.12	1.3619	10	57.25	1.5187	37. 0	58.51	1.7990
20	50.48	0.9885	6	54.57	1.2439	25	56.13	1.3646	20	57.27	1.5225	30	58.53	1.8045
30	51. 3	1.0000	9	54.58	1.2460	30	56.15	1.3672	30	57.28	1.5262	38. 0	58.54	1.8100
40	51.16	1.0113	12	55. 0	1.2481	35	56.16	1.3699	40	57.30	1.5299	30	58.55	1.8154
50	51.30	1.0223	15	55. 1	1.2501	40	56.17	1.3725	50	57.31	1.5336	39. 0	58.57	1.8206
6. 0	51.42	1.0336	10.18	55. 3	1.2522	13.45	56.19	1.3751	20. 0	57.33	1.5372	39.30	58.58	1.8257
10	51.55	1.0437	21	55. 4	1.2543	50	56.20	1.3777	10	57.34	1.5408	40. 0	58.59	1.8307
20	52. 6	1 0541	24	55. 6	1.2563	55	56.22	1.3803	20	57.35	1.5444	30	59. 0	1.8357
30	52.17	1.0643	27	55. 7	1.2583	14. 0	56.23	1.3828	30	57.37	1.5480	41. 0	59. 1	1.8406
40	52.28	1.0742	30	55. 8	1.2603	5	56.24	1.3853	40	57.38	1.5515	30	59. 2	1.8454
50	52.38	1.0840	33	55.10	1.2623	10	56.26	1.3878	50	57.39	1.5550	42. 0	59. 3	1.8500
7. 0	52.48	1.093[illegible]	10.36	55.11	1.2643	14.15	56.27	1.3904	21. 0	57.41	1.5585	42.30	59. 4	1.8546
10	52.57	1.1029	39	55.13	1.2663	20	56.28	1.3929	10	57.42	1.5619	43. 0	59. 5	1.8593
20	53. 6	1.1122	42	55.14	1.2683	25	56.30	1.3954	20	57.43	1.5653	30	59. 6	1.8638
30	53.15	1.1212	45	55.15	1.2702	30	56.31	1.3979	30	57.44	1.5686	44. 0	59. 7	1.8683
35	53.19	1.1257	48	55.17	1.2722	35	56.32	1.4004	40	57.46	1.5719	30	59. 8	1.8726
40	53.23	1.1301	51	55.18	1.2742	40	56.3[illegible]	1.4029	50	57.47	1.5752	45. 0	59. 9	1.8763
7.45	53.27	1.1345	10.54	55.19	1.2761	14.45	56.35	1.4053	22. 0	57.48	1.5784	46.	59.11	1.8848
48	53.30	1.1371	57	55.20	1.2780	50	56.36	1.4077	10	57.49	1.5817	47.	59.13	1.8928
51	53.32	1.1397	11. 0	55.22	1.2799	55	56.37	1.4101	20	57.50	1.5849	48.	59.15	1.9004
54	53.35	1.1423	3	55.23	1.2818	15. 0	56.38	1.4125	30	57.51	1.5881	49.	59.16	1.9081
57	53.37	1.1448	6	55.24	1.2837	5	56.39	1.4149	40	57.52	1.5913	50.	59.18	1.9154
8. 0	53.39	1.1474	9	55.26	1.2856	10	56.41	1.4173	50	57.53	1.5945	51.	59.19	1.9225
8. 3	53.41	1.1499	11.12	55.27	1.2875	15.15	56.42	1.4197	23. 0	57.54	1.5976	52.	59.21	1.9294
6	53.44	1.1524	15	55.28	1.2894	20	56.43	1.4221	10	57.56	1.6008	53.	59.22	1.9362
9	53.46	1.1550	18	55.29	1.2913	25	56.44	1.4244	20	57.57	1.6039	54.	59.24	1.9424
12	53.48	1.1575	21	55.30	1.2932	30	56.45	1.4267	30	57.58	1.6070	55.	59.25	1.9484
15	53.50	1.1599	24	55.32	1.2951	35	56.46	1.4290	40	57.59	1.6101	56.	59.26	1.9544
18	53.52	1.1624	27	55.33	1.2970	40	56.47	1.4313	50	58. 0	1.6131	57.	59.28	1.9602
8.21	53.55	1.1649	11.30	55.34	1.2988	15.45	56.49	1.4336	24. 0	58. 1	1.6161	58.	59.29	1.9658
24	53.57	1.1673	33	55.35	1.3007	50	56.50	1.4359	10	58. 2	1.6191	59.	59.30	1.9715
27	53.59	1.1698	36	55.36	1.3025	55	56.51	1.4382	20	58. 3	1.6221	60.	59.31	1.9761
30	54. 1	1.1722	39	55.38	1.3043	16. 0	56.52	1.4404	30	58. 3	1.6250	61.	59.33	1.9807
33	54. 3	1.1746	42	55.39	1.3061	5	56.53	1.4427	40	58. 4	1.6279	62.	59.34	1.9854
36	54. 5	1.1770	45	55.40	1.3079	10	56.54	1.4449	50	58. 5	1.6308	63.	59.35	1.9901
8.39	54. 7	1.1794	11.48	55.41	1.3097	16.15	56.55	1.4471	25. 0	58. 6	1.6336	64.	59.36	1.9946
42	54. 9	1.1818	51	55.42	1.3115	20	56.56	1.4493	20	58. 8	1.6393	65.	59.37	1.9986
45	54.11	1.1841	54	55.43	1.3133	25	56.57	1.4515	40	58.10	1.6449	66	59.38	2.0025
48	54.13	1.1865	57	55.44	1.3151	30	56.58	1.4537	26. 0	58.11	1.6505	67.	59.39	2.0064
51	54.15	1.1888	12. 0	55.45	1.3169	35	56.59	1.4559	20	58.13	1.6559	68.	59.40	2.0100
54	54.16	1.1912	3	55.46	1.3187	40	57. 0	1.4581	40	58.15	1.6612	69.	59.41	2.0136
8.57	54.18	1.1935	12. 6	55.48	1.3205	16.45	57. 1	1.4602	27. 0	58.16	1.6665	70.	59.42	2.0173
9. 0	54.20	1.1958	9	55.49	1.3223	50	57. 2	1.4624	20	58.18	1.6718	71.	59.43	2.0208
3	54.22	1.1981	12	55.50	1.3240	55	57. 3	1.4646	40	58.19	1.6771	72.	59.44	2.0238
6	54.24	1.2004	15	55.51	1.3257	17. 0	57. 4	1.4667	28. 0	58.21	1.6824	73.	59.45	2.0268
9	54.26	1.2026	18	55.52	1.3275	5	57. 5	1.4688	20	58.22	1.6874	74.	59.46	2.0296
12	54.27	1.2049	21	55.53	1.3292	10	57. 6	1.4709	40	58.24	1.6923	75.	59.47	2.0322
9.15	54.29	1.2071	12.24	55.54	1.3309	17.15	57. 6	1.4730	29. 0	58.25	1.6972	76.	59.48	2.0343
18	54.31	1.2094	27	55.55	1.3326	20	57. 7	1.4751	30	58.27	1.7046	77.	59.49	2.0363
21	54.33	1.2116	30	55 56	1.3343	25	57. 8	1.4772	30. 0	58.29	1.7117	78.	59.50	2.0382
24	54.34	1.2139	33	55.57	1.3360	30	57. 9	1.4793	30	56.31	1.7187	79.	59.51	2.0400
27	54.36	1.2161	36	55.58	1.3377	35	57.10	1.4814	31. 0	58.33	1.7255	80.	59.52	2.0417
30	54.38	1.2183	39	55.59	1.3394	40	57.11	1.4835	30	58.35	1.7321	81.	59.52	2.0432
9.33	54.39	1.2205	12.42	56. 0	1.3411	17.45	57.12	1.4855	32. 0	58.36	1.7387	82.	59.53	2.0446
36	54.41	1.2227	45	56. 1	1.3427	50	57.13	1.4876	30	58.38	1.7454	83.	59.54	2.0450
39	54.43	1.2248	48	56. 2	1.3444	55	57.14	1.4896	33. 0	58.40	1.7520	84.	59.55	2.0453
42	54.44	1.2270	51	56. 3	1.3461	18. 0	57.14	1.4916	30	58.41	1.7582	85.	59.56	2.0456
45	54.46	1.2291	54	56. 4	1.3478	10	57.16	1.4956	34. 0	58.43	1.7643	86.	59.57	2.0458
48	54.48	1.2313	57	56. 5	1.3494	20	57.18	1.4995	30	58.44	1.7702	87.	59.57	2.0460
9.51	54.49	1.2334	13. 0	56. 6	1.3510	18.30	57.19	1.5034	35. 0	58.46	1.7762	88.	59.58	2.0461
54	54.51	1.2355	5	56. 7	1.3538	40	57.21	1.5073	30	58.47	1.7821	89.	59.59	2.0462
57	54.52	1.2376	10	56. 9	1.3565	50	57.22	1.5111	36. 0	58.49	1.7878	90.	60. 0	2.0462

TABLE XIX.

CORRECTION.

Ap. Alt. ☽ cent. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Prop. part for Seconds of Paral. Add. S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
5		14.35	13.35	12.35	11.36	10.36	9.36	8.36	7.37	0	59	58	57	56	55	54	53	52	51	50
	10	14.20	13.20	12.20	11.20	10.21	9.21	8.21	7.21	10	49	48	47	46	45	44	43	42	41	40
	20	14. 5	13. 5	12. 6	11. 6	10. 6	9. 6	8. 7	7. 7	20	39	38	37	36	35	34	33	32	31	30
	30	13.51	12.52	11.52	10.52	9.52	8.53	7.53	6.53	30	29	28	27	26	25	24	23	22	21	20
	40	13.38	12.39	11.39	10.39	9.39	8.40	7.40	6.40	40	19	18	17	16	15	14	13	12	11	10
	50	13.26	12.26	11.27	10.27	9.27	8.27	7.28	6.28	50	9	8	7	6	5	4	3	2	1	0
6	0	13.17	12.18	11.18	10.18	9.19	8.19	7.19	6.20	0	59	58	57	56	55	54	53	52	51	50
	10	13. 6	12. 7	11. 7	10. 7	9. 8	8. 8	7. 8	6. 8	10	49	48	47	46	45	44	43	42	41	40
	20	12.55	11.56	10.56	9.57	8.57	7.57	6.58	5.58	20	39	38	37	36	35	34	33	32	31	30
	30	12.45	11.46	10.46	9.46	8.47	7.47	6.48	5.48	30	29	28	27	26	25	24	23	22	21	20
	40	12.36	11.36	10.37	9.37	8.37	7.38	6.38	5.39	40	19	18	17	16	15	14	13	12	11	10
	50	12.27	11.27	10 28	9.28	8.28	7.29	6.29	5.30	50	9	8	7	6	5	4	3	2	1	0
	0	12.18	11.19	10.19	9.19	8.20	7.20	6.21	5.21											

Tab. B. For M. of Alt. Add.

M	S	M	S
0	12	0	9
1	11	1	8
2	9	2	7
3	8	3	6
4	7	4	5
5	6	5	4
6	4	6	3
7	3	7	2
8	2	8	1
9	0	9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 5° 0′	5 10	5 20	5 30	5 40	5 50	6 0	6 10	6 20	6 30	6 40	6 50	7 0	Tab. C. C. for S. of Par. Add. S	C
54	0	3084	3058	3033	3009	2987	2966	2946	2926	2908	2891	2874	2859	2844	0	14
	10	3068	3041	3016	2993	2971	2950	2930	2911	2892	2875	2859	2843	2828	1	13
	20	3051	3025	3000	2977	2955	2934	2914	2895	2877	2860	2843	2827	2813	2	11
	30	3035	3009	2984	2961	2939	2918	2898	2879	2861	2844	2828	2812	2797	3	9
	40	3019	2993	2968	2945	2923	2902	2883	2864	2846	2828	2812	2797	2782	4	8
	50	3003	2977	2952	2929	2907	2887	2867	2848	2830	2813	2797	2781	2767	5	6
55	0	2987	2961	2936	2913	2891	2871	2851	2833	2815	2798	2781	2766	2751	6	5
	10	2971	2945	2921	2898	2876	2855	2836	2817	2799	2782	2766	2751	2736	7	3
	20	2955	2929	2905	2882	2860	2840	2820	2802	2784	2767	2751	2736	2721	8	1
	30	2939	2913	2889	2866	2845	2824	2805	2786	2769	2752	2736	2720	2706	9	0
	40	2923	2897	2873	2851	2829	2809	2790	2771	2753	2737	2721	2705	2691		
	50	2907	2882	2858	2835	2814	2795	2774	2756	2738	2721	2706	2690	2676	S	C
56	0	2891	2866	2842	2820	2798	2778	2759	2741	2723	2706	2690	2675	2661	0	14
	10	2876	2851	2827	2804	2783	2763	2744	2725	2708	2691	2676	2660	2646	1	13
	20	2860	2835	2811	2789	2768	2748	2729	2710	2693	2676	2661	2646	2631	2	11
	30	2844	2820	2796	2774	2752	2732	2714	2695	2678	2661	2646	2631	2617	3	10
	40	2829	2801	2780	2758	2737	2717	2698	2680	2663	2647	2631	2616	2602	4	8
	50	2813	2789	2765	2743	2722	2702	2683	2665	2648	2632	2616	2601	2587	5	7
57	0	2798	2773	2750	2728	2707	2687	2669	2650	2633	2617	2601	2587	2573	6	5
	10	2783	2758	2735	2713	2692	2672	2654	2636	2618	2602	2587	2572	2558	7	4
	20	2767	2743	2720	2698	2677	2657	2639	2621	2604	2588	2572	2557	2543	8	2
	30	2752	2728	2705	2683	2662	2642	2624	2606	2589	2573	2558	2543	2529	9	1
	40	2737	2713	2690	2668	2647	2628	2609	2591	2574	2558	2543	2528	2515		
	50	2722	2698	2675	2653	2632	2613	2595	2577	2560	2544	2529	2514	2500	S	C
58	0	2707	2683	2660	2638	2618	2598	2580	2562	2545	2529	2514	2500	2486	0	14
	10	2692	2668	2645	2623	2603	2584	2565	2548	2531	2515	2500	2485	2472	1	13
	20	2677	2653	2630	2609	2588	2569	2551	2533	2516	2501	2485	2471	2457	2	11
	30	2662	2638	2615	2594	2574	2554	2536	2519	2502	2486	2471	2457	2443	3	10
	40	2647	2623	2601	2579	2559	2540	2522	2504	2488	2472	2457	2443	2429	4	8
	50	2632	2608	2586	2565	2544	2525	2507	2490	2473	2458	2443	2428	2415	5	7
59	0	2617	2594	2571	2550	2530	2511	2493	2476	2459	2444	2429	2414	2401	6	5
	10	2603	2579	2557	2536	2516	2497	2479	2461	2445	2429	2415	2400	2387	7	4
	20	2588	2565	2542	2521	2501	2482	2465	2447	2431	2415	2400	2386	2373	8	2
	30	2573	2550	2528	2507	2487	2468	2450	2433	2417	2401	2386	2372	2359	9	1
	40	2559	2535	2513	2492	2473	2454	2436	2419	2403	2387	2373	2358	2345		
	50	2544	2521	2499	2478	2458	2440	2422	2405	2389	2373	2359	2345	2331	S	C
60	0	2530	2507	2485	2464	2444	2426	2408	2391	2375	2359	2345	2331	2317	0	14
	10	2515	2492	2470	2450	2430	2411	2394	2377	2361	2345	2331	2317	2304	1	13
	20	2501	2478	2456	2435	2416	2397	2380	2363	2347	2332	2317	2303	2290	2	11
	30	2487	2464	2442	2421	2402	2383	2366	2349	2333	2318	2303	2290	2276	3	10
	40	2472	2450	2428	2407	2388	2369	2352	2335	2319	2304	2290	2276	2263	4	8
	50	2458	2435	2414	2393	2374	2356	2339	2321	2306	2290	2276	2262	2249	5	7
61	0	2444	2421	2400	2379	2360	2342	2325	2308	2292	2277	2262	2249	2236	6	6
	10	2430	2407	2386	2365	2346	2328	2311	2294	2278	2263	2249	2235	2222	7	4
	20	2416	2393	2372	2351	2332	2314	2297	2280	2265	2250	2235	2222	2209	8	3
	30	2402	2379	2358	2338	2318	2300	2283	2267	2251	2236	2222	2208	2195	9	1

TABLE XIX.

CORRECTION.

App. alt. D	☾'s cen. M	☾'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
7	0	12.21	11.22	10.22	9.22	8.23	7.23	6.24	5.24
	10	12.13	11.13	10.14	9.14	8.15	7.15	6.16	5.16
	20	12. 5	11. 5	10. 6	9. 6	8. 7	7. 7	6. 8	5. 8
	30	11.58	10.58	9.59	8.59	8. 0	7. 0	6. 1	5. 1
	40	11.50	10.51	9.51	8.52	7.53	6.53	5.54	4.54

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	59	58	57	56	55	54	53	52	51	50
10	49	48	47	46	45	44	43	42	41	40
20	39	38	37	36	35	34	33	32	31	30
30	29	28	27	26	25	24	23	22	21	20
40	19	18	17	16	15	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	6
1	5
2	5
3	4
4	3
5	3
6	2
7	1
8	0
9	0

TABLE XIX. LOGARITHMS.

☾'s Hor. Parallax. M	S	Apparent Altitude of ☾'s centre. 7° 3′	7° 6′	7° 9′	7° 12′	7° 15′	7° 18′	7° 21′	7° 24′	7° 27′	7° 30′	7° 33′	7° 36′
54	0	2841	2836	2831	2827	2823	2819	2815	2811	2807	2803	2799	2795
	10	2825	2821	2816	2812	2808	2804	2800	2796	2791	2787	2783	2780
	20	2810	2805	2800	2796	2792	2788	2784	2780	2776	2772	2768	2765
	30	2794	2790	2785	2781	2777	2773	2769	2765	2761	2757	2753	2749
	40	2779	2774	2770	2766	2762	2758	2754	2750	2746	2742	2738	2734
	50	2764	2759	2755	2751	2747	2743	2739	2735	2731	2727	2723	2719
55	0	2748	2744	2739	2735	2731	2727	2723	2719	2716	2712	2708	2704
	10	2733	2729	2724	2720	2716	2712	2708	2704	2700	2696	2692	2689
	20	2718	2714	2709	2705	2701	2697	2693	2689	2685	2681	2677	2674
	30	2703	2699	2694	2690	2686	2682	2678	2674	2671	2667	2663	2659
	40	2688	2684	2679	2675	2671	2667	2663	2659	2656	2652	2648	2644
	50	2673	2669	2664	2660	2656	2653	2649	2645	2641	2637	2633	2630
56	0	2658	2654	2649	2645	2641	2638	2634	2630	2626	2622	2618	2615
	10	2643	2639	2635	2631	2627	2623	2619	2615	2611	2607	2603	2600
	20	2628	2624	2620	2616	2612	2608	2604	2600	2597	2593	2589	2586
	30	2614	2610	2606	2602	2598	2594	2590	2586	2582	2578	2574	2571
	40	2599	2595	2591	2587	2583	2579	2575	2571	2567	2563	2559	2556
	50	2584	2580	2576	2572	2568	2564	2560	2556	2553	2549	2545	2542
57	0	2570	2566	2562	2558	2554	2550	2546	2542	2538	2534	2530	2527
	10	2555	2551	2547	2543	2539	2535	2531	2527	2524	2520	2516	2513
	20	2540	2536	2532	2528	2525	2521	2517	2513	2510	2506	2502	2499
	30	2526	2522	2518	2514	2510	2506	2503	2499	2495	2491	2487	2484
	40	2512	2508	2504	2500	2496	2492	2488	2484	2481	2477	2473	2470
	50	2497	2493	2489	2485	2481	2478	2474	2470	2467	2463	2459	2456
58	0	2483	2479	2475	2471	2467	2463	2460	2456	2452	2448	2444	2441
	10	2469	2465	2461	2457	2453	2449	2445	2441	2438	2434	2430	2427
	20	2454	2450	2446	2442	2438	2435	2431	2427	2424	2420	2416	2413
	30	2440	2436	2432	2428	2424	2421	2417	2413	2410	2406	2402	2399
	40	2426	2422	2418	2414	2410	2407	2403	2399	2396	2392	2388	2385
	50	2412	2408	2404	2400	2396	2393	2389	2385	2382	2378	2374	2371
59	0	2398	2394	2390	2386	2382	2379	2375	2371	2368	2364	2360	2357
	10	2384	2380	2376	2372	2368	2365	2361	2357	2354	2350	2346	2343
	20	2370	2366	2362	2358	2354	2351	2347	2343	2340	2336	2332	2329
	30	2356	2352	2348	2345	2341	2337	2334	2330	2327	2323	2319	2316
	40	2342	2338	2334	2331	2327	2323	2320	2316	2313	2309	2305	2302
	50	2328	2324	2320	2317	2313	2309	2306	2302	2299	2295	2291	2288
60	0	2314	2311	2307	2303	2299	2296	2292	2289	2286	2282	2278	2275
	10	2301	2297	2293	2290	2286	2282	2279	2275	2272	2268	2264	2261
	20	2287	2283	2279	2276	2272	2268	2265	2261	2258	2254	2250	2247
	30	2273	2270	2266	2262	2258	2255	2251	2248	2245	2241	2237	2234
	40	2260	2256	2252	2249	2245	2241	2238	2234	2231	2227	2223	2220
	50	2246	2243	2239	2235	2231	2228	2224	2221	2218	2214	2210	2207
61	0	2233	2229	2225	2222	2218	2214	2211	2207	2204	2200	2196	2193
	10	2219	2216	2212	2209	2205	2201	2198	2194	2191	2187	2183	2180
	20	2206	2202	2198	2195	2191	2187	2184	2181	2178	2174	2170	2167
	30	2192	2189	2185	2182	2178	2174	2171	2167	2164	2160	2157	2154

Table C. Cor. for Seconds of Parallax. Add

S.	Cor
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	1
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	1
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cen. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Proportional part for Seconds of Parallax. Add. S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
7	30	11.58	10.58	9.59	8.59	8. 0	7. 0	6. 1	5. 1	0	59	58	57	56	55	54	53	52	51	50
	40	11.50	10.51	9.51	8.52	7.53	6.53	5.54	4.54	10	49	48	47	46	45	44	43	42	41	40
	50	11.44	10.44	9.45	8.45	7.46	6.46	5.47	4.47	20	39	38	37	36	35	34	33	32	31	30
8	0	11.37	10.38	9.38	8.39	7.40	6.40	5.41	4.41	30	29	28	27	26	25	24	23	22	21	20
	10	11.31	10.32	9.32	8.33	7.33	6.34	5.35	4.35	40	19	18	17	16	15	14	13	12	11	10
	20	11.25	10.26	9.26	8.27	7.28	6.28	5.29	4.30	50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	6
1	5
2	5
3	4
4	3
5	3
6	2
7	1
8	0
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	″	Apparent Altitude of ☽'s centre. 7° 39′	7° 42′	7° 45′	7° 48′	7° 51′	7° 54′	7° 57′	8° 0′	8° 3′	8° 6′	8° 9′	8° 12′
54	0	2791	2787	2783	2780	2777	2774	2770	2766	2762	2759	2756	2753
	10	2776	2772	2768	2765	2762	2759	2755	2751	2747	2744	2741	2738
	20	2761	2757	2753	2750	2747	2743	2739	2736	2732	2729	2726	2723
	30	2745	2741	2737	2734	2731	2727	2724	2721	2717	2714	2711	2708
	40	2730	2726	2722	2719	2716	2712	2709	2706	2702	2699	2696	2693
	50	2715	2711	2707	2704	2701	2697	2694	2691	2687	2684	2681	2678
55	0	2700	2696	2692	2689	2686	2682	2679	2676	2672	2669	2666	2663
	10	2685	2681	2677	2674	2671	2667	2664	2661	2657	2654	2651	2648
	20	2670	2666	2662	2659	2656	2652	2649	2646	2642	2639	2636	2633
	30	2655	2651	2647	2644	2641	2637	2634	2631	2627	2624	2621	2618
	40	2640	2637	2633	2630	2627	2623	2619	2616	2612	2609	2606	2603
	50	2626	2622	2618	2615	2612	2608	2605	2602	2598	2595	2592	2589
56	0	2611	2607	2603	2600	2597	2593	2590	2587	2583	2580	2577	2574
	10	2596	2592	2589	2586	2583	2579	2575	2572	2569	2566	2563	2560
	20	2582	2578	2574	2571	2568	2564	2561	2558	2554	2551	2548	2545
	30	2567	2563	2559	2556	2553	2549	2546	2543	2540	2537	2534	2531
	40	2552	2548	2545	2542	2539	2535	2532	2529	2525	2522	2519	2516
	50	2538	2534	2530	2527	2524	2520	2517	2514	2511	2508	2505	2502
57	0	2523	2519	2516	2513	2510	2506	2503	2500	2496	2493	2490	2487
	10	2509	2505	2502	2499	2496	2492	2489	2486	2482	2479	2476	2473
	20	2495	2491	2487	2484	2481	2477	2474	2471	2468	2465	2462	2459
	30	2480	2476	2473	2470	2467	2463	2460	2457	2454	2451	2448	2445
	40	2466	2462	2459	2456	2453	2449	2446	2443	2440	2437	2434	2431
	50	2452	2448	2445	2442	2439	2435	2432	2429	2425	2422	2419	2416
58	0	2438	2434	2431	2428	2425	2421	2418	2415	2411	2408	2405	2402
	10	2424	2420	2416	2413	2410	2407	2404	2401	2397	2394	2391	2388
	20	2410	2406	2402	2399	2396	2393	2390	2387	2383	2380	2377	2374
	30	2396	2392	2388	2385	2382	2379	2376	2373	2369	2366	2363	2360
	40	2382	2378	2375	2372	2369	2365	2362	2359	2356	2353	2350	2347
	50	2368	2364	2361	2358	2355	2351	2348	2345	2342	2339	2336	2333
59	0	2354	2350	2347	2344	2341	2337	2334	2331	2328	2325	2322	2319
	10	2340	2336	2333	2330	2327	2323	2320	2317	2314	2311	2308	2305
	20	2326	2322	2319	2316	2313	2310	2307	2304	2301	2298	2295	2292
	30	2312	2308	2305	2302	2299	2296	2293	2290	2287	2284	2281	2278
	40	2299	2295	2292	2289	2286	2282	2279	2276	2273	2270	2267	2264
	50	2285	2281	2278	2275	2272	2269	2266	2263	2260	2257	2254	2251
60	0	2271	2268	2265	2262	2259	2255	2252	2249	2246	2243	2240	2237
	10	2258	2254	2251	2248	2245	2242	2239	2236	2233	2230	2227	2224
	20	2244	2240	2237	2234	2231	2228	2225	2222	2219	2216	2213	2210
	30	2231	2227	2224	2221	2218	2215	2212	2209	2206	2203	2200	2197
	40	2217	2214	2211	2208	2205	2201	2198	2195	2192	2189	2186	2183
	50	2204	2200	2197	2194	2191	2188	2185	2182	2179	2176	2173	2170
61	0	2190	2187	2184	2181	2178	2175	2172	2169	2166	2163	2160	2157
	10	2177	2174	2171	2168	2165	2161	2158	2155	2152	2149	2147	2144
	20	2164	2160	2157	2154	2151	2148	2145	2142	2139	2136	2133	2130
	30	2151	2147	2144	2141	2138	2135	2132	2129	2126	2123	2120	2117

Table C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	1
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	1
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cen. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
8	10	11.33	10.34	9.34	8.35	7.35	6.36	5.37	4.37
	20	11.27	10.28	9.28	8.29	7.30	6.30	5.31	4.32
	30	11.22	10.22	9.23	8.24	7.24	6.25	5.25	4.26
	40	11.16	10.17	9.18	8.18	7.19	6.20	5.20	4.21
	50	11.11	10.12	9.13	8.13	7.14	6.15	5.15	4.16

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	58	57	56	55	54	53	52	51	50	49
10	48	47	46	45	44	43	42	41	40	39
20	38	37	36	35	34	33	32	31	30	29
30	28	27	26	25	24	23	22	21	20	19
40	18	17	16	15	14	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of Alt. Add.

M	S
0	5
1	4
2	4
3	3
4	3
5	2
6	2
7	1
8	1
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	S.	Apparent Altitude of ☽'s centre. 8° 15′	8° 18′	8° 21′	8° 24′	8° 27′	8° 30′	8° 33′	8° 36′	8° 39′	8° 42′	8° 45′	8° 48′
54	0	2749	2746	2743	2740	2737	2734	2731	2728	2725	2722	2719	2716
	10	2734	2731	2728	2725	2722	2719	2716	2713	2710	2707	2704	2701
	20	2719	2716	2713	2710	2707	2704	2701	2698	2695	2692	2689	2686
	30	2704	2701	2698	2695	2692	2689	2686	2683	2680	2677	2674	2671
	40	2689	2686	2683	2680	2677	2674	2671	2668	2665	2662	2659	2656
	50	2675	2671	2668	2665	2662	2659	2656	2653	2650	2647	2644	2641
55	0	2659	2656	2653	2650	2647	2644	2641	2638	2635	2632	2629	2627
	10	2644	2641	2638	2635	2632	2629	2626	2623	2620	2617	2614	2612
	20	2629	2626	2623	2620	2617	2614	2611	2609	2606	2603	2600	2597
	30	2615	2612	2609	2606	2603	2600	2597	2594	2591	2588	2585	2583
	40	2600	2597	2594	2591	2588	2585	2582	2579	2576	2573	2570	2568
	50	2536	2582	2579	2576	2573	2570	2567	2564	2562	2559	2556	2553
56	0	2571	2568	2565	2562	2559	2556	2553	2550	2547	2544	2541	2539
	10	2556	2553	2550	2547	2544	2541	2538	2535	2533	2530	2527	2524
	20	2542	2539	2536	2533	2530	2527	2524	2521	2518	2515	2512	2510
	30	2527	2524	2521	2518	2515	2512	2509	2506	2504	2501	2498	2496
	40	2513	2510	2507	2504	2501	2498	2495	2492	2490	2487	2484	2481
	50	2499	2496	2493	2490	2437	2484	2481	2478	2475	2472	2469	2467
57	0	2484	2481	2478	2475	2472	2469	2466	2463	2461	2458	2455	2453
	10	2470	2467	2464	2461	2458	2455	2452	2449	2447	2444	2441	2439
	20	2456	2453	2450	2447	2444	2441	2438	2435	2433	2430	2427	2425
	30	2442	2439	2436	2433	2430	2427	2424	2421	2419	2416	2413	2411
	40	2427	2424	2421	2418	2416	2413	2410	2407	2405	2402	2399	2397
	50	2413	2410	2407	2404	2402	2399	2396	2393	2391	2388	2385	2383
58	0	2399	2396	2393	2390	2388	2385	2382	2379	2377	2374	2371	2369
	10	2385	2382	2379	2376	2374	2371	2368	2365	2363	2360	2357	2355
	20	2371	2368	2365	2362	2360	2357	2354	2351	2349	2346	2343	2341
	30	2357	2355	2352	2349	2346	2343	2340	2337	2335	2332	2329	2327
	40	2344	2341	2338	2335	2332	2329	2326	2323	2321	2318	2315	2313
	50	2330	2327	2324	2321	2318	2315	2312	2309	2307	2304	2302	2300
59	0	2316	2313	2310	2307	2305	2302	2299	2296	2294	2291	2289	2286
	10	2302	2299	2296	2293	2291	2288	2285	2282	2280	2277	2275	2272
	20	2289	2286	2283	2280	2277	2274	2271	2268	2266	2263	2261	2259
	30	2275	2272	2269	2266	2264	2261	2258	2255	2253	2250	2248	2245
	40	2261	2259	2256	2253	2250	2247	2244	2241	2239	2236	2234	2232
	50	2248	2245	2242	2239	2237	2234	2231	2228	2226	2223	2221	2218
60	0	2234	2232	2229	2226	2223	2220	2217	2214	2212	2209	2207	2205
	10	2221	2218	2215	2212	2209	2207	2204	2201	2199	2196	2194	2191
	20	2207	2205	2202	2199	2196	2193	2190	2188	2186	2183	2181	2178
	30	2194	2191	2188	2185	2183	2180	2177	2175	2172	2169	2167	2165
	40	2180	2178	2175	2172	2170	2167	2164	2162	2159	2156	2154	2152
	50	2167	2165	2162	2159	2157	2154	2151	2149	2146	2143	2141	2138
61	0	2154	2151	2148	2145	2143	2140	2137	2135	2133	2130	2128	2125
	10	2141	2138	2135	2132	2130	2127	2124	2122	2119	2116	2114	2112
	20	2127	2125	2122	2119	2117	2114	2111	2109	2106	2103	2101	2099
	30	2114	2112	2109	2106	2104	2101	2098	2096	2093	2090	2088	2086

Table C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	1
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	1
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cen. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
8	50	11.12	10.13	9.14	8.14	7.15	6.16	5.16	4.17
9	0	11. 7	10. 8	9. 9	8.10	7.10	6.11	5.12	4.13
	10	11. 3	10. 4	9. 4	8. 5	7. 6	6. 7	5. 7	4. 8
	20	10.59	9.59	9. 0	8. 1	7. 2	6. 2	5. 3	4. 4
	30	10.54	9.55	8.56	7.57	6.58	5.58	4.59	4. 0

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	58	57	56	55	54	53	52	51	50	49
10	48	47	46	45	44	43	42	41	40	39
20	38	37	36	35	34	33	32	31	30	29
30	28	27	26	25	24	23	22	22	21	20
40	19	18	17	16	15	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	4
1	4
2	3
3	3
4	2
5	2
6	2
7	1
8	1
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 8° 51′	8° 54′	8° 57′	9° 0′	9° 3′	9° 6′	9° 9′	9° 12′	9° 15′	9° 18′	9° 21′	9° 24′	9° 27′	Table C. Cor. for Seconds of Parallax. Add. S.	Cor.
54	0	2713	2710	2708	2705	2702	2699	2697	2694	2691	2688	2686	2684	2682	0	13
	10	2698	2695	2693	2690	2687	2685	2682	2679	2676	2673	2671	2669	2667	1	12
	20	2683	2680	2678	2675	2672	2670	2667	2664	2661	2658	2656	2654	2652	2	10
	30	2668	2665	2663	2660	2657	2655	2652	2649	2646	2643	2641	2639	2637	3	9
	40	2653	2650	2648	2645	2642	2640	2637	2634	2632	2629	2627	2625	2622	4	7
	50	2638	2635	2633	2630	2627	2625	2622	2619	2617	2614	2612	2610	2608	5	6
55	0	2624	2621	2619	2616	2613	2611	2608	2605	2602	2599	2597	2595	2593	6	4
	10	2609	2606	2604	2601	2598	2596	2593	2590	2588	2585	2583	2581	2578	7	3
	20	2594	2591	2589	2586	2583	2581	2578	2575	2573	2570	2568	2566	2564	8	1
	30	2580	2577	2575	2572	2569	2566	2564	2561	2558	2555	2553	2551	2549	9	0
	40	2565	2562	2560	2557	2554	2551	2549	2546	2544	2541	2539	2537	2535		
	50	2550	2547	2545	2542	2539	2537	2535	2532	2529	2526	2524	2522	2520	S.	Cor.
56	0	2536	2533	2531	2528	2525	2523	2520	2517	2515	2512	2510	2508	2506	0	13
	10	2521	2519	2517	2514	2511	2509	2506	2503	2501	2498	2496	2494	2492	1	12
	20	2507	2504	2502	2499	2496	2494	2492	2489	2486	2483	2481	2479	2477	2	10
	30	2493	2490	2438	2485	2482	2480	2477	2474	2472	2469	2467	2465	2463	3	9
	40	2478	2476	2474	2471	2468	2466	2463	2460	2458	2455	2453	2451	2449	4	7
	50	2464	2461	2459	2456	2453	2451	2449	2446	2444	2441	2439	2437	2434	5	6
57	0	2450	2447	2445	2442	2439	2437	2435	2432	2430	2427	2425	2423	2420	6	4
	10	2436	2433	2431	2428	2425	2423	2421	2418	2415	2413	2410	2408	2406	7	3
	20	2422	2419	2417	2414	2412	2409	2407	2404	2401	2399	2396	2394	2392	8	1
	30	2408	2405	2403	2400	2398	2395	2393	2390	2387	2385	2382	2380	2378	9	0
	40	2394	2391	2389	2386	2384	2381	2379	2376	2373	2371	2368	2366	2364		
	50	2380	2377	2375	2372	2370	2367	2365	2362	2360	2357	2355	2353	2351	S.	Cor.
58	0	2366	2363	2361	2358	2356	2353	2351	2348	2346	2343	2341	2339	2337	0	13
	10	2352	2349	2347	2344	2342	2339	2337	2334	2332	2329	2327	2325	2323	1	12
	20	2338	2335	2333	2330	2328	2325	2323	2320	2318	2315	2313	2311	2309	2	10
	30	2324	2322	2320	2317	2314	2312	2309	2306	2304	2301	2299	2297	2295	3	9
	40	2310	2308	2306	2303	2300	2298	2296	2293	2291	2288	2286	2284	2282	4	7
	50	2297	2294	2292	2289	2287	2284	2282	2279	2277	2274	2272	2270	2268	5	6
59	0	2283	2281	2279	2276	2273	2270	2268	2265	2263	2260	2258	2256	2254	6	5
	10	2269	2267	2265	2262	2260	2257	2255	2252	2250	2247	2245	2243	2241	7	3
	20	2256	2253	2251	2248	2246	2243	2241	2238	2236	2233	2231	2229	2227	8	2
	30	2242	2240	2238	2235	2232	2230	2228	2225	2223	2220	2218	2216	2214	9	1
	40	2229	2226	2224	2221	2218	2216	2214	2211	2209	2207	2205	2203	2201		
	50	2215	2213	2211	2208	2205	2203	2201	2198	2196	2193	2191	2189	2187	S.	Cor.
60	0	2202	2200	2198	2195	2192	2190	2188	2185	2183	2180	2178	2176	2174	0	13
	10	2188	2186	2184	2181	2178	2176	2174	2171	2169	2166	2164	2162	2160	1	12
	20	2175	2173	2171	2168	2165	2163	2161	2158	2156	2153	2151	2149	2147	2	10
	30	2162	2160	2158	2155	2152	2150	2148	2145	2143	2140	2138	2136	2134	3	9
	40	2149	2146	2144	2141	2138	2136	2134	2131	2129	2127	2125	2123	2121	4	8
	50	2135	2133	2131	2128	2125	2123	2121	2118	2116	2114	2112	2110	2108	5	6
61	0	2122	2120	2118	2115	2112	2110	2108	2105	2103	2101	2099	2097	2095	6	5
	10	2109	2107	2105	2102	2099	2097	2095	2092	2090	2088	2086	2034	2082	7	4
	20	2096	2094	2092	2089	2086	2084	2082	2079	2077	2074	2072	2070	2068	8	2
	30	2083	2081	2079	2076	2073	2071	2069	2066	2064	2061	2059	2057	2055	9	1

CORRECTION.

App. alt. D	☽'s cen. M	54′	55′	56′	57′	58′	59′	60′	61′
9	30	10.55	9.56	8.57	7.58	6.59	5.59	5. 0	4. 1
	40	10.51	9.52	8.53	7.54	6.55	5.56	4.56	3.57
	50	10.48	9.49	8.49	7.50	6.51	5.52	4.53	3.54
10	0	10.44	9.45	8.46	7.47	6.48	5.49	4.50	3.50
	10	10.41	9.42	8.43	7.44	6.45	5.45	4.46	3.47
	20	10.38	9.39	8.40	7.41	6.41	5.42	4.43	3.44

(Column heading: ☽'s Horizontal Parallax.)

TABLE A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	58	57	56	55	54	53	52	51	50	49
10	48	47	46	45	44	43	42	41	40	39
20	38	37	36	35	34	33	32	31	30	29
30	28	27	26	25	24	24	23	22	21	20
40	19	18	17	16	15	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	3
1	3
2	2
3	2
4	2
5	2
6	1
7	1
8	1
9	1

TABLE XIX. LOGARITHMS.

Apparent Altitude of ☽'s centre.

☽'s Hor. Parallax. M	S	9° 30′	9° 34′	9° 38′	9° 42′	9° 46′	9° 50′	9° 54′	9° 58′	10° 2′	10° 6′	10° 10′	10° 14′	10° 18′
54	0	2679	2676	2673	2669	2666	2663	2660	2657	2654	2651	2648	2645	2642
	10	2664	2661	2658	2654	2651	2648	2645	2642	2640	2637	2634	2631	2628
	20	2649	2646	2643	2639	2636	2633	2630	2627	2625	2622	2619	2616	2613
	30	2634	2631	2628	2624	2621	2618	2615	2612	2610	2607	2604	2601	2598
	40	2619	2616	2613	2610	2607	2604	2601	2598	2595	2592	2589	2587	2584
	50	2605	2602	2599	2595	2592	2589	2586	2583	2581	2578	2575	2572	2569
55	0	2590	2587	2584	2580	2577	2574	2571	2568	2566	2563	2560	2557	2554
	10	2575	2572	2569	2566	2563	2560	2557	2554	2552	2549	2546	2543	2540
	20	2561	2558	2555	2551	2548	2545	2542	2539	2537	2534	2531	2528	2525
	30	2546	2543	2540	2537	2534	2531	2528	2525	2523	2520	2517	2514	2511
	40	2532	2529	2526	2523	2520	2517	2514	2511	2508	2505	2502	2500	2497
	50	2517	2514	2511	2508	2505	2502	2499	2496	2494	2491	2488	2485	2482
56	0	2503	2500	2497	2494	2491	2488	2485	2482	2480	2477	2474	2471	2468
	10	2489	2486	2483	2480	2477	2474	2471	2468	2465	2462	2459	2457	2454
	20	2474	2471	2468	2465	2462	2459	2456	2453	2451	2448	2445	2443	2440
	30	2460	2457	2454	2451	2448	2445	2442	2439	2437	2434	2431	2428	2425
	40	2446	2443	2440	2437	2434	2431	2428	2425	2423	2420	2417	2414	2411
	50	2432	2429	2426	2423	2420	2417	2414	2411	2409	2406	2403	2400	2397
57	0	2418	2415	2412	2409	2406	2403	2400	2397	2395	2392	2389	2386	2383
	10	2404	2401	2398	2395	2392	2389	2386	2383	2381	2378	2375	2372	2369
	20	2390	2387	2384	2381	2378	2375	2372	2369	2367	2364	2361	2358	2355
	30	2376	2373	2370	2367	2364	2361	2358	2355	2353	2350	2347	2345	2342
	40	2362	2359	2356	2353	2350	2347	2344	2341	2339	2336	2333	2331	2328
	50	2348	2345	2342	2339	2336	2333	2330	2327	2325	2322	2319	2317	2314
58	0	2334	2331	2328	2325	2322	2319	2316	2313	2311	2308	2306	2303	2300
	10	2320	2317	2314	2311	2308	2306	2303	2300	2298	2295	2292	2290	2287
	20	2306	2303	2300	2297	2294	2292	2289	2286	2284	2281	2278	2276	2273
	30	2293	2290	2287	2284	2281	2278	2275	2272	2270	2267	2264	2262	2259
	40	2279	2276	2273	2270	2267	2265	2262	2259	2257	2254	2251	2249	2246
	50	2265	2262	2259	2257	2254	2251	2243	2245	2243	2240	2237	2235	2232
59	0	2252	2249	2246	2243	2240	2238	2235	2232	2230	2227	2224	2222	2219
	10	2238	2235	2233	2230	2227	2224	2221	2218	2216	2213	2210	2208	2205
	20	2225	2222	2219	2216	2213	2211	2208	2205	2203	2200	2197	2195	2192
	30	2211	2208	2206	2203	2200	2197	2194	2191	2189	2186	2184	2182	2179
	40	2198	2195	2192	2189	2186	2184	2181	2178	2176	2173	2170	2168	2165
	50	2185	2182	2179	2176	2173	2171	2168	2165	2163	2160	2157	2155	2152
60	0	2171	2168	2166	2163	2160	2158	2155	2152	2150	2147	2144	2142	2139
	10	2158	2155	2152	2149	2146	2144	2141	2138	2136	2133	2131	2129	2126
	20	2145	2142	2139	2136	2133	2131	2128	2125	2123	2120	2117	2115	2112
	30	2132	2129	2126	2123	2120	2118	2115	2112	2110	2107	2104	2102	2099
	40	2118	2115	2113	2110	2107	2105	2102	2099	2097	2094	2091	2089	2086
	50	2105	2102	2100	2097	2094	2092	2089	2086	2084	2081	2078	2076	2073
61	0	2092	2089	2087	2084	2081	2079	2076	2073	2071	2068	2065	2063	2060
	10	2079	2076	2074	2071	2068	2066	2063	2060	2058	2055	2052	2050	2047
	20	2066	2063	2061	2058	2055	2053	2050	2047	2045	2042	2039	2037	2034
	30	2053	2050	2048	2045	2042	2040	2037	2034	2032	2029	2027	2025	2022

TABLE C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. D	☽'s cen. M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
10	20	10.38	9.39	8.40	7.41	6.41	5.42	4.43	3.44
	30	10.35	9.36	8.37	7.38	6.39	5.40	4.41	3.42
	40	10.32	9.33	8.34	7.35	6.36	5.37	4.38	3.39
	50	10.29	9.30	8.31	7.32	6.33	5.34	4.35	3.36
11	0	10.27	9.28	8.29	7.30	6.31	5.32	4.33	3.34
	10	10.24	9.25	8.26	7.27	6.29	5.30	4.31	3.32

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	58	57	56	55	54	53	52	51	50	49
10	43	47	46	45	44	43	42	41	40	39
20	38	37	36	35	34	33	32	31	30	29
30	29	28	27	26	25	24	23	22	21	20
40	19	18	17	16	15	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	3
1	3
2	2
3	2
4	2
5	2
6	1
7	1
8	1
9	1

TABLE XIX. LOGARITHMS.

Apparent Altitude of ☽'s centre.

☽'s Hor. Parallax. M	S.	10°22′	10°26′	10°30′	10°34′	10°38′	10°42′	10°46′	10°50′	10°54′	10°58′	11°2′	11°6′
54	0	2639	2637	2634	2631	2628	2626	2623	2621	2618	2616	2614	2611
	10	2625	2622	2619	2616	2613	2611	2608	2606	2603	2601	2599	2597
	20	2610	2608	2605	2602	2599	2597	2594	2591	2588	2586	2584	2582
	30	2595	2593	2590	2587	2584	2582	2579	2577	2574	2572	2570	2567
	40	2581	2578	2575	2572	2570	2568	2565	2562	2560	2557	2555	2552
	50	2566	2564	2561	2558	2555	2553	2550	2548	2545	2543	2541	2538
55	0	2551	2549	2546	2543	2540	2538	2535	2533	2530	2528	2526	2523
	10	2537	2535	2532	2529	2526	2524	2521	2519	2516	2514	2512	2509
	20	2522	2520	2517	2514	2512	2510	2507	2504	2502	2499	2497	2495
	30	2508	2506	2503	2500	2497	2495	2492	2490	2487	2485	2483	2480
	40	2494	2492	2489	2486	2483	2481	2478	2476	2473	2471	2469	2466
	50	2479	2477	2474	2471	2469	2467	2464	2462	2459	2457	2455	2452
56	0	2465	2463	2460	2457	2455	2453	2450	2447	2445	2442	2440	2438
	10	2451	2449	2446	2443	2440	2438	2435	2433	2430	2428	2426	2424
	20	2437	2435	2432	2429	2426	2424	2421	2419	2416	2414	2412	2410
	30	2423	2420	2418	2415	2412	2410	2407	2405	2402	2400	2398	2396
	40	2409	2406	2404	2401	2398	2396	2393	2391	2388	2386	2384	2382
	50	2395	2392	2390	2387	2384	2382	2379	2377	2374	2372	2370	2368
57	0	2381	2378	2376	2373	2370	2368	2365	2363	2360	2358	2356	2354
	10	2367	2364	2362	2359	2356	2354	2351	2349	2346	2344	2342	2340
	20	2353	2350	2348	2345	2342	2340	2337	2335	2333	2331	2329	2326
	30	2339	2337	2334	2331	2329	2327	2324	2322	2319	2317	2315	2312
	40	2325	2323	2320	2317	2315	2313	2310	2308	2305	2303	2301	2299
	50	2311	2309	2306	2303	2301	2299	2296	2294	2291	2289	2287	2285
58	0	2298	2295	2293	2290	2238	2256	2283	2281	2278	2276	2274	2271
	10	2284	2282	2279	2276	2274	2272	2269	2267	2264	2262	2260	2258
	20	2270	2268	2265	2262	2260	2258	2255	2253	2251	2249	2247	2244
	30	2257	2254	2252	2249	2247	2245	2242	2240	2237	2235	2233	2231
	40	2243	2241	2238	2235	2233	2231	2228	2226	2224	2222	2220	2217
	50	2230	2227	2225	2222	2220	2218	2215	2213	2210	2208	2206	2204
59	0	2216	2214	2211	2208	2206	2204	2201	2199	2197	2195	2193	2191
	10	2203	2200	2198	2195	2193	2191	2188	2186	2183	2181	2179	2177
	20	2190	2187	2185	2182	2180	2178	2175	2173	2170	2168	2166	2164
	30	2176	2174	2171	2168	2166	2164	2161	2159	2157	2155	2153	2151
	40	2163	2160	2158	2155	2153	2151	2148	2146	2144	2142	2140	2138
	50	2150	2147	2145	2142	2140	2138	2135	2133	2130	2128	2126	2124
60	0	2137	2134	2132	2129	2127	2125	2122	2120	2117	2115	2113	2111
	10	2123	2121	2118	2115	2113	2111	2109	2107	2104	2102	2100	2098
	20	2110	2107	2105	2102	2100	2098	2096	2094	2091	2089	2087	2085
	30	2097	2094	2092	2089	2087	2085	2033	2081	2078	2076	2074	2072
	40	2034	2081	2079	2076	2074	2072	2070	2068	2065	2063	2061	2059
	50	2071	2068	2066	2063	2061	2059	2057	2055	2052	2050	2048	2046
61	0	2058	2055	2053	2050	2048	2046	2044	2042	2039	2037	2035	2033
	10	2045	2042	2040	2037	2035	2033	2031	2029	2026	2024	2022	2020
	20	2032	2029	2027	2024	2022	2020	2018	2016	2014	2012	2010	2008
	30	2020	2017	2015	2012	2009	2007	2005	2003	2001	1999	1997	1995

Table C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. D	☽'s cen. M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
11	10	10.25	9.26	8.27	7.28	6.30	5.31	4.32	3.33
	20	10.23	9.24	8.25	7.26	6.28	5.29	4.30	3.31
	30	10.21	9.22	8.23	7.24	6.26	5.27	4.28	3.29
	40	10.19	9.20	8.21	7.22	6.24	5.25	4.26	3.27
	50	10.17	9.18	8.19	7.21	6.22	5.23	4.24	3.26
12	0	10.15	9.16	8.18	7.19	6.20	5.22	4.23	3.24

TABLE A.
Proportional part for Seconds of Parallax.
Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	58	57	56	55	54	53	52	51	50	49
10	48	47	46	45	44	43	42	41	40	39
20	38	37	36	35	34	33	33	32	31	30
30	29	28	27	26	25	24	23	22	21	20
40	19	18	17	16	15	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B
For M of alt.
Add.

M	S
0	2
1	2
2	2
3	1
4	1
5	1
	1
7	1
8	0
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 11° 10′	11° 15′	11° 20′	11° 25′	11° 30′	11° 35′	11° 40′	11° 45′	11° 50′	11° 55′	12°
54	0	2609	2606	2603	2600	2597	2594	2592	2589	2586	2584	2581
	10	2594	2591	2588	2585	2582	2579	2577	2574	2571	2569	2566
	20	2579	2576	2573	2571	2568	2565	2563	2560	2557	2555	2552
	30	2565	2562	2559	2556	2553	2550	2548	2545	2542	2540	2537
	40	2550	2547	2544	2542	2539	2536	2534	2531	2528	2526	2523
	50	2536	2533	2530	2527	2524	2521	2519	2516	2513	2511	2508
55	0	2521	2518	2515	2513	2510	2507	2505	2502	2499	2497	2494
	10	2507	2504	2501	2498	2495	2492	2490	2487	2485	2482	2480
	20	2493	2490	2487	2484	2481	2478	2476	2473	2470	2468	2465
	30	2478	2475	2472	2470	2467	2464	2462	2459	2456	2454	2451
	40	2464	2461	2458	2456	2453	2450	2448	2445	2442	2440	2437
	50	2450	2447	2444	2442	2439	2436	2434	2431	2428	2426	2423
56	0	2436	2433	2430	2427	2424	2421	2419	2416	2414	2411	2409
	10	2422	2419	2416	2413	2410	2407	2405	2402	2400	2397	2395
	20	2408	2405	2402	2399	2396	2393	2391	2383	2386	2383	2381
	30	2394	2391	2388	2385	2382	2379	2377	2374	2372	2369	2367
	40	2380	2377	2374	2371	2368	2365	2363	2360	2358	2355	2353
	50	2366	2363	2360	2357	2354	2352	2349	2347	2344	2342	2339
57	0	2352	2349	2346	2344	2341	2338	2336	2333	2330	2328	2325
	10	2338	2335	2332	2330	2327	2324	2322	2319	2317	2314	2312
	20	2324	2321	2318	2316	2313	2310	2308	2305	2303	2300	2298
	30	2310	2307	2304	2302	2299	2297	2294	2292	2289	2287	2284
	40	2297	2294	2291	2289	2286	2283	2281	2278	2276	2273	2271
	50	2283	2280	2277	2275	2272	2269	2267	2264	2262	2259	2257
58	0	2269	2266	2263	2261	2258	2256	2253	2251	2248	2246	2243
	10	2256	2253	2250	2248	2245	2242	2240	2237	2235	2232	2230
	20	2242	2239	2236	2234	2231	2229	2226	2224	2221	2219	2216
	30	2229	2226	2223	2221	2218	2215	2213	2210	2208	2205	2203
	40	2215	2212	2209	2207	2204	2202	2199	2197	2195	2192	2190
	50	2202	2199	2196	2194	2191	2189	2186	2184	2181	2179	2176
59	0	2189	2186	2183	2181	2178	2175	2173	2170	2168	2165	2163
	10	2175	2172	2169	2167	2164	2162	2159	2157	2155	2152	2150
	20	2162	2159	2156	2154	2151	2149	2146	2144	2141	2139	2136
	30	2149	2146	2143	2141	2138	2135	2133	2130	2128	2125	2123
	40	2136	2133	2130	2128	2125	2122	2120	2117	2115	2112	2110
	50	2122	2119	2117	2114	2112	2109	2107	2104	2102	2099	2097
60	0	2109	2106	2104	2101	2099	2096	2094	2091	2089	2086	2084
	10	2096	2093	2091	2088	2086	2083	2081	2078	2076	2073	2071
	20	2083	2080	2078	2075	2073	2070	2068	2065	2063	2060	2058
	30	2070	2067	2065	2062	2060	2057	2055	2052	2050	2047	2045
	40	2057	2054	2052	2049	2047	2044	2042	2039	2037	2034	2032
	50	2044	2041	2039	2036	2034	2031	2029	2026	2024	2021	2019
61	0	2031	2028	2026	2023	2021	2018	2016	2013	2011	2008	2006
	10	2018	2015	2013	2010	2008	2006	2003	2001	1999	1996	1994
	20	2006	2003	2000	1998	1995	1993	1990	1988	1986	1983	1981
	30	1993	1990	1987	1985	1982	1980	1977	1975	1973	1970	1968

TABLE C.
Cor. for Seconds of Parallax.
Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

☽'s cen.		☽'s Horizontal Parallax.							
°	M	54′	55′	56′	57′	58′	59′	60′	61′
2	0	10.16	9.17	8.19	7.20	6.21	5.23	4.24	3.25
	10	10.15	9.16	8.17	7.19	6.20	5.21	4.23	3.24
	20	10.13	9.14	8.16	7.17	6.19	5.20	4.21	3.23
	30	10.12	9.13	8.14	7.16	6.17	5.19	4.20	3.22
	40	10.10	9.12	8.13	7.15	6.16	5.18	4.19	3.21
	50	10. 9	9.11	8.12	7.14	6.15	5.17	4.18	3.20

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	58	57	56	55	54	53	52	51	50	49
10	48	47	46	45	44	43	42	41	40	39
20	38	37	37	36	35	34	33	32	31	30
30	29	28	27	26	25	24	23	22	21	20
40	19	18	17	16	15	14	13	12	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	1
1	1
2	1
3	1
4	1
5	1
6	0
7	0
8	0
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax.		Apparent Altitude of ☽'s centre.										
		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
M	S.	12 5	12 10	12 15	12 20	12 25	12 30	12 35	12 40	12 45	12 50	12 55
54	0	2578	2576	2573	2571	2568	2566	2564	2561	2559	2557	2554
	10	2564	2561	2559	2556	2554	2551	2549	2546	2544	2542	2540
	20	2549	2547	2544	2542	2539	2537	2535	2532	2530	2528	2525
	30	2534	2532	2529	2527	2524	2522	2520	2517	2515	2513	2511
	40	2520	2518	2515	2513	2510	2508	2506	2503	2501	2499	2496
	50	2506	2503	2501	2499	2496	2494	2492	2489	2487	2485	2482
55	0	2491	2489	2486	2484	2481	2479	2477	2474	2472	2470	2468
	10	2477	2475	2472	2470	2467	2465	2463	2460	2458	2456	2454
	20	2463	2461	2458	2456	2453	2451	2449	2446	2444	2442	2439
	30	2449	2447	2444	2442	2439	2437	2435	2432	2430	2428	2425
	40	2435	2433	2430	2428	2425	2423	2421	2418	2416	2414	2411
	50	2421	2419	2416	2414	2411	2409	2407	2404	2402	2400	2397
56	0	2407	2405	2402	2400	2397	2395	2393	2390	2388	2386	2383
	10	2393	2391	2388	2386	2383	2381	2379	2376	2374	2372	2369
	20	2379	2377	2374	2372	2369	2367	2365	2362	2360	2358	2355
	30	2365	2363	2360	2358	2355	2353	2351	2348	2346	2344	2341
	40	2351	2349	2346	2344	2341	2339	2337	2334	2332	2330	2328
	50	2337	2335	2332	2330	2327	2325	2323	2320	2318	2316	2314
57	0	2323	2321	2318	2316	2313	2311	2309	2307	2305	2303	2300
	10	2310	2307	2304	2302	2300	2298	2296	2293	2291	2289	2287
	20	2296	2294	2291	2289	2286	2284	2282	2279	2277	2275	2273
	30	2282	2280	2277	2275	2272	2270	2268	2266	2264	2262	2259
	40	2269	2266	2263	2261	2259	2257	2255	2252	2250	2248	2246
	50	2255	2252	2250	2248	2245	2243	2241	2239	2237	2235	2232
58	0	2241	2238	2236	2234	2232	2230	2228	2225	2223	2221	2219
	10	2228	2225	2223	2221	2218	2216	2214	2212	2210	2208	2205
	20	2214	2211	2209	2207	2205	2203	2201	2198	2196	2194	2192
	30	2201	2198	2196	2194	2191	2189	2187	2185	2183	2181	2179
	40	2188	2185	2183	2181	2178	2176	2174	2172	2170	2168	2165
	50	2174	2171	2169	2167	2165	2163	2161	2158	2156	2154	2152
59	0	2161	2158	2156	2154	2151	2149	2147	2145	2143	2141	2139
	10	2148	2145	2143	2141	2138	2136	2134	2132	2130	2128	2126
	20	2134	2132	2130	2128	2125	2123	2121	2119	2117	2115	2113
	30	2121	2118	2116	2114	2112	2110	2108	2106	2104	2102	2100
	40	2108	2105	2103	2101	2099	2097	2095	2092	2090	2088	2086
	50	2095	2092	2090	2088	2086	2084	2082	2079	2077	2075	2073
60	0	2082	2079	2077	2075	2073	2071	2069	2066	2064	2062	2060
	10	2069	2066	2064	2062	2060	2058	2056	2054	2052	2050	2048
	20	2056	2053	2051	2049	2047	2045	2043	2041	2039	2037	2035
	30	2043	2040	2038	2036	2034	2032	2030	2028	2026	2024	2022
	40	2030	2027	2025	2023	2021	2019	2017	2015	2013	2011	2009
	50	2017	2015	2013	2011	2008	2006	2004	2002	2000	1998	1996
61	0	2004	2002	2000	1998	1995	1993	1991	1989	1987	1985	1983
	10	1992	1989	1987	1985	1983	1981	1979	1977	1975	1973	1970
	20	1979	1976	1974	1972	1970	1968	1966	1964	1962	1960	1958
	30	1966	1964	1962	1960	1957	1955	1953	1951	1949	1947	1945

Table C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	4
7	3
8	2
9	0
S.	**Cor.**
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0
S.	**Cor.**
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1
S.	**Cor.**
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. D	☽'s cen. M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
13	0	10.10	9.12	8.13	7.15	6.16	5.18	4.19	3.21
	10	10. 9	9.11	8.12	7.14	6.15	5.17	4.19	3.20
	20	10. 8	9.10	8.12	7.13	6.15	5.16	4.18	3.20
	30	10. 8	9. 9	8.11	7.13	6.14	5.16	4.17	3.19
	40	10. 7	9. 9	8.10	7.12	6.14	5.15	4.17	3.19
	50	10. 6	9. 8	8.10	7.12	6.13	5.15	4.17	3.18

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	57	56	55	54	53	52	51	50	49	48
10	47	46	45	44	43	42	41	40	39	39
20	38	37	36	35	34	33	32	31	30	29
30	28	27	26	25	24	23	22	21	20	19
40	18	17	16	15	14	13	12	11	10	9
50	8	7	6	5	4	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 13° 0′	13° 5′	13° 10′	13° 15′	13° 20′	13° 25′	13° 30′	13° 35′	13° 40′	13° 45′	13° 50′	13° 55′
54	0	2552	2550	2548	2545	2543	2541	2539	2537	2535	2533	2531	2529
	10	2538	2536	2534	2531	2529	2527	2525	2523	2521	2519	2517	2515
	20	2523	2521	2519	2517	2515	2513	2511	2509	2507	2505	2503	2501
	30	2509	2507	2505	2502	2500	2498	2496	2494	2492	2490	2488	2486
	40	2494	2492	2490	2488	2486	2484	2482	2480	2478	2476	2474	2472
	50	2480	2478	2476	2474	2472	2470	2468	2466	2464	2462	2460	2458
55	0	2466	2464	2462	2460	2458	2456	2454	2452	2450	2448	2446	2444
	10	2452	2450	2448	2446	2444	2442	2440	2438	2436	2434	2432	2430
	20	2437	2435	2433	2431	2429	2427	2425	2423	2421	2419	2417	2415
	30	2423	2421	2419	2417	2415	2413	2411	2409	2407	2405	2403	2401
	40	2409	2407	2405	2403	2401	2399	2397	2395	2393	2391	2389	2387
	50	2395	2393	2391	2389	2387	2385	2383	2381	2379	2377	2375	2373
56	0	2381	2379	2377	2375	2373	2371	2369	2367	2365	2364	2362	2360
	10	2367	2365	2363	2361	2359	2357	2355	2353	2351	2350	2348	2346
	20	2353	2351	2349	2347	2345	2343	2341	2339	2337	2336	2334	2332
	30	2339	2337	2335	2333	2331	2329	2327	2325	2323	2322	2320	2318
	40	2326	2324	2322	2320	2318	2316	2314	2312	2310	2308	2306	2304
	50	2312	2310	2308	2306	2304	2302	2300	2298	2296	2295	2293	2291
57	0	2298	2296	2294	2292	2290	2288	2286	2284	2282	2281	2279	2277
	10	2285	2283	2281	2279	2277	2275	2273	2271	2269	2267	2265	2263
	20	2271	2269	2267	2265	2263	2261	2259	2257	2255	2254	2252	2250
	30	2257	2255	2253	2251	2249	2247	2245	2243	2241	2240	2238	2236
	40	2244	2242	2240	2238	2236	2234	2232	2230	2228	2227	2225	2223
	50	2230	2228	2226	2224	2222	2220	2218	2216	2214	2213	2211	2209
58	0	2217	2215	2213	2211	2209	2207	2205	2203	2201	2200	2198	2196
	10	2203	2201	2199	2198	2196	2194	2192	2190	2188	2187	2185	2183
	20	2190	2188	2186	2184	2182	2180	2178	2176	2174	2173	2171	2169
	30	2177	2175	2173	2171	2169	2167	2165	2163	2161	2160	2158	2156
	40	2163	2161	2159	2158	2156	2154	2152	2150	2148	2147	2145	2143
	50	2150	2148	2146	2145	2143	2141	2139	2137	2135	2134	2132	2130
59	0	2137	2135	2133	2131	2129	2127	2125	2123	2122	2120	2118	2117
	10	2124	2122	2120	2118	2116	2114	2112	2110	2108	2107	2105	2103
	20	2111	2109	2107	2105	2103	2101	2099	2097	2095	2094	2092	2090
	30	2098	2096	2094	2092	2090	2088	2086	2084	2082	2081	2079	2077
	40	2085	2083	2081	2079	2077	2075	2073	2071	2069	2068	2066	2064
	50	2072	2070	2068	2066	2064	2062	2060	2058	2056	2055	2053	2051
60	0	2059	2057	2055	2053	2051	2049	2047	2045	2043	2042	2040	2038
	10	2046	2044	2042	2040	2038	2036	2034	2032	2031	2029	2027	2026
	20	2033	2031	2029	2027	2025	2023	2021	2019	2018	2016	2014	2013
	30	2020	2018	2016	2014	2012	2010	2008	2006	2005	2003	2001	2000
	40	2007	2005	2003	2002	2000	1998	1996	1994	1992	1990	1989	1987
	50	1994	1992	1990	1989	1987	1985	1983	1981	1979	1977	1976	1974
61	0	1981	1979	1977	1976	1974	1972	1970	1968	1967	1965	1963	1962
	10	1969	1967	1965	1963	1961	1959	1957	1955	1954	1952	1950	1949
	20	1956	1954	1952	1951	1949	1947	1945	1943	1942	1940	1938	1937
	30	1943	1941	1939	1938	1936	1934	1932	1930	1929	1927	1925	1924

Table C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	3
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	3
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	7
6	5
7	4
8	3
9	2

TABLE XIX.

CORRECTION.

App. alt. ☽'s cen. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′
14	0	10. 6	9. 8	8. 9	7.11	6.13	5.15	4.17	3.18
	10	10. 5	9. 7	8. 9	7.11	6.13	5.15	4.16	3.18
	20	10. 5	9. 7	8. 9	7.11	6.13	5.14	4.16	3.18
	30	10. 5	9. 7	8. 9	7.11	6.13	5.14	4.16	3.18
	40	10. 5	9. 7	8. 9	7.11	6.13	5.15	4.16	3.18
	50	10. 5	9. 7	8. 9	7.11	6.13	5.15	4.17	3.19

Table A. Proportional part for Seconds of Parallax. Add.

S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
0	57	56	55	54	53	52	51	50	49	48
10	47	46	45	44	43	42	42	41	40	39
20	38	37	36	35	34	33	32	31	30	29
30	28	27	26	25	24	23	22	21	20	19
40	18	17	16	15	14	13	12	11	11	10
50	9	8	7	6	5	4	3	2	1	0

Tab. B For M of alt. Add.

M	S
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0

TABLE XIX. LOGARITHMS.

☽'s Hor. Parallax. M	S.	Apparent Altitude of ☽'s centre. 14° 0′	14° 5′	14° 10′	14° 15′	14° 20′	14° 25′	14° 30′	14° 35′	14° 40′	14° 45′	14° 50′	14° 55′
54	0	2527	2525	2523	2521	2520	2518	2516	2514	2513	2511	2509	2508
	10	2513	2511	2509	2507	2506	2504	2502	2500	2499	2497	2495	2494
	20	2499	2497	2495	2493	2492	2490	2488	2486	2485	2483	2481	2480
	30	2484	2482	2480	2478	2477	2475	2473	2471	2470	2468	2466	2465
	40	2470	2468	2466	2464	2463	2461	2459	2457	2456	2454	2452	2451
	50	2456	2454	2452	2450	2449	2447	2445	2443	2442	2440	2438	2437
55	0	2442	2440	2438	2436	2435	2433	2431	2429	2428	2426	2424	2423
	10	2428	2426	2424	2422	2421	2419	2417	2415	2414	2412	2410	2409
	20	2413	2412	2410	2408	2406	2405	2403	2401	2400	2398	2396	2395
	30	2399	2398	2396	2394	2392	2391	2389	2387	2386	2384	2382	2381
	40	2385	2384	2382	2380	2378	2377	2375	2373	2372	2370	2368	2367
	50	2371	2370	2368	2366	2364	2363	2361	2359	2358	2356	2354	2353
56	0	2358	2356	2354	2352	2351	2349	2347	2345	2344	2342	2340	2339
	10	2344	2342	2340	2338	2337	2335	2333	2331	2330	2328	2326	2325
	20	2330	2328	2326	2324	2323	2321	2319	2317	2316	2315	2313	2312
	30	2316	2314	2313	2311	2309	2308	2306	2304	2303	2301	2299	2298
	40	2302	2300	2299	2297	2295	2294	2292	2290	2289	2287	2285	2284
	50	2289	2287	2285	2283	2282	2280	2278	2276	2275	2274	2272	2271
57	0	2275	2273	2272	2270	2268	2267	2265	2263	2262	2260	2258	2257
	10	2261	2259	2258	2256	2254	2253	2251	2249	2248	2246	2244	2243
	20	2248	2246	2245	2243	2241	2240	2238	2236	2235	2233	2231	2230
	30	2234	2232	2231	2229	2227	2226	2224	2222	2221	2219	2217	2216
	40	2221	2219	2218	2216	2214	2213	2211	2209	2208	2206	2204	2203
	50	2207	2205	2204	2202	2200	2199	2197	2195	2194	2193	2191	2190
58	0	2194	2192	2191	2189	2187	2186	2184	2182	2181	2179	2177	2176
	10	2181	2179	2178	2176	2174	2173	2171	2169	2168	2166	2164	2163
	20	2167	2165	2164	2162	2160	2159	2157	2155	2154	2153	2151	2150
	30	2154	2152	2151	2149	2147	2146	2144	2142	2141	2140	2138	2137
	40	2141	2139	2138	2136	2134	2133	2131	2129	2128	2126	2124	2123
	50	2128	2126	2125	2123	2121	2120	2118	2116	2115	2113	2111	2110
59	0	2115	2113	2112	2110	2108	2107	2105	2103	2102	2100	2098	2097
	10	2101	2099	2098	2096	2094	2093	2091	2089	2088	2087	2085	2084
	20	2088	2086	2085	2083	2081	2080	2078	2076	2075	2074	2072	2071
	30	2075	2073	2072	2070	2068	2067	2065	2063	2062	2061	2059	2058
	40	2062	2060	2059	2057	2055	2054	2052	2050	2049	2048	2046	2045
	50	2049	2047	2046	2045	2043	2042	2040	2038	2037	2035	2033	2032
60	0	2036	2034	2033	2032	2030	2029	2027	2025	2024	2022	2020	2019
	10	2024	2022	2021	2019	2017	2016	2014	2012	2011	2010	2008	2007
	20	2011	2009	2008	2006	2004	2003	2001	1999	1998	1997	1995	1994
	30	1998	1996	1995	1993	1991	1990	1988	1986	1985	1984	1982	1981
	40	1985	1983	1982	1980	1978	1977	1975	1973	1972	1971	1969	1968
	50	1972	1970	1969	1968	1966	1965	1963	1961	1960	1959	1957	1956
61	0	1960	1958	1957	1955	1953	1952	1950	1948	1947	1946	1944	1943
	10	1947	1945	1944	1942	1940	1939	1937	1935	1934	1933	1931	1930
	20	1935	1933	1932	1930	1928	1927	1925	1923	1922	1921	1919	1918
	30	1922	1920	1919	1917	1915	1914	1912	1910	1909	1908	1906	1905

Table C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	3
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	3
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	7
6	5
7	4
8	3
9	2

Ap. alt. ☽ cent.		☽'s Horizontal Parallax.								Table A. Prop. part for Sec. of Paral. Add.											Tab. B. For Miles of alt. Add.	
D	M	54′	55′	56′	57′	58′	59′	60′	61′	S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	M	S
15	0	10. 5	9. 7	8. 9	7.11	6.13	5.15	4.17	3.19	0	57	56	55	54	53	52	51	50	49	48	0	0
	10	10. 5	9. 7	8. 9	7.11	6.13	5.15	4.17	3.19	10	47	46	45	44	43	43	42	41	40	39	1	0
	20	10. 5	9. 7	8. 9	7.11	6.13	5.16	4.18	3.20	20	38	37	36	35	34	33	32	31	30	29	2	0
	30	10. 5	9. 7	8.10	7.12	6.14	5.16	4.18	3.20	30	28	27	26	25	24	23	22	21	20	19	3	0
	40	10. 6	9. 8	8.10	7.12	6.14	5.17	4.19	3.21	40	18	17	16	16	15	14	13	12	11	10	4	0
	50	10. 6	9. 8	8.10	7.13	6.15	5.17	4.19	3.22	50	9	8	7	6	5	4	3	2	1	0	5	0
																					6	0
																					7	0
																					8	0
																					9	0
16	0	10. 6	9. 9	8.11	7.13	6.16	5.18	4.20	3.23	0	57	56	55	54	53	52	51	50	49	48	0	0
	10	10. 7	9. 9	8.12	7.14	6.16	5.19	4.21	3.23	10	47	46	45	45	44	43	42	41	40	39	1	0
	20	10. 7	9.10	8.12	7.15	6.17	5.20	4.22	3.24	20	38	37	36	35	34	33	32	31	30	29	2	0
	30	10. 8	9.11	8.13	7.15	6.18	5.20	4.23	3.25	30	28	27	26	25	24	23	22	21	21	20	3	0
	40	10. 9	9.11	8.14	7.16	6.19	5.21	4.24	3.26	40	19	18	17	16	15	14	13	12	11	10	4	0
	50	10.10	9.12	8.15	7.17	6.20	5.22	4.25	3.27	50	9	8	7	6	5	4	3	2	1	0	5	0
																					6	0
																					7	0
																					8	1
																					9	1

TABLE XIX. LOGARITHMS.

☽ Hor. Paral.		Apparent Altitude of ☽'s centre.											
		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
M	S	15 0	15 10	15 20	15 30	15 40	15 50	16 0	16 10	16 20	16 30	16 40	16 50
54	0	2506	2503	2500	2497	2494	2491	2488	2485	2482	2479	2476	2474
	10	2492	2488	2485	2482	2179	2476	2473	2471	2468	2465	2462	2460
	20	2478	2474	2471	2468	2465	2462	2459	2457	2454	2451	2448	2446
	30	2463	2460	2457	2454	2451	2448	2445	2442	2439	2436	2434	2431
	40	2449	2446	2443	2440	2437	2434	2431	2428	2425	2422	2420	2417
	50	2435	2432	2429	2426	2423	2420	2417	2414	2411	2408	2406	2403
55	0	2421	2418	2415	2412	2409	2406	2403	2400	2397	2394	2392	2389
	10	2407	2404	2401	2398	2395	2392	2389	2386	2383	2380	2378	2375
	20	2393	2390	2387	2384	2381	2378	2375	2372	2369	2366	2364	2361
	30	2379	2376	2373	2370	2367	2364	2361	2358	2355	2352	2350	2347
	40	2365	2362	2359	2356	2353	2350	2347	2344	2342	2339	2336	2334
	50	2351	2348	2345	2342	2339	2336	2333	2330	2328	2325	2322	2320
56	0	2337	2334	2331	2328	2325	2322	2319	2316	2314	2311	2308	2306
	10	2323	2320	2317	2314	2311	2308	2305	2302	2300	2297	2295	2292
	20	2310	2307	2304	2301	2298	2295	2292	2289	2287	2284	2281	2279
	30	2296	2293	2290	2287	2284	2281	2278	2275	2273	2270	2267	2265
	40	2282	2279	2276	2273	2270	2267	2264	2261	2259	2256	2254	2251
	50	2269	2265	2262	2259	2257	2254	2251	2248	2246	2243	2240	2238
57	0	2255	2252	2249	2246	2243	2240	2237	2234	2232	2229	2227	2224
	10	2241	2238	2235	2232	2230	2227	2224	2221	2219	2216	2213	2211
	20	2228	2225	2222	2219	2216	2213	2210	2207	2205	2203	2200	2198
	30	2214	2211	2208	2205	2203	2200	2197	2194	2192	2189	2187	2184
	40	2201	2198	2195	2192	2190	2187	2184	2181	2179	2176	2173	2171
	50	2188	2185	2182	2179	2176	2173	2170	2167	2165	2162	2160	2157
58	0	2174	2171	2168	2165	2163	2160	2157	2154	2152	2149	2147	2144
	10	2161	2158	2155	2152	2150	2147	2144	2141	2139	2136	2134	2131
	20	2148	2145	2142	2139	2137	2134	2131	2128	2126	2123	2121	2118
	30	2135	2132	2129	2126	2123	2120	2117	2114	2112	2110	2108	2105
	40	2121	2119	2116	2113	2110	2107	2104	2101	2099	2097	2094	2092
	50	2108	2106	2103	2100	2097	2094	2091	2088	2086	2084	2081	2079
59	0	2095	2092	2089	2086	2084	2081	2078	2075	2073	2071	2068	2066
	10	2082	2079	2076	2073	2071	2068	2065	2062	2060	2058	2055	2053
	20	2069	2066	2063	2060	2058	2055	2052	2049	2047	2045	2042	2040
	30	2056	2053	2050	2047	2045	2042	2039	2036	2034	2032	2030	2027
	40	2043	2041	2038	2035	2032	2029	2026	2023	2021	2019	2017	2014
	50	2030	2028	2025	2022	2020	2017	2014	2011	2009	2006	2004	2001
60	0	2017	2015	2012	2009	2007	2004	2001	1998	1996	1993	1991	1988
	10	2005	2002	1999	1996	1994	1991	1988	1985	1983	1981	1979	1976
	20	1992	1989	1986	1983	1981	1978	1975	1972	1970	1968	1966	1963
	30	1979	1977	1974	1971	1969	1966	1963	1960	1958	1955	1953	1950
	40	1966	1964	1961	1958	1956	1953	1950	1947	1945	1942	1940	1937
	50	1954	1951	1948	1945	1943	1940	1937	1934	1932	1930	1928	1925
61	0	1941	1939	1936	1933	1931	1928	1925	1922	1920	1917	1915	1912
	10	1928	1926	1923	1920	1918	1915	1912	1909	1907	1905	1902	1900
	20	1916	1914	1911	1908	1906	1903	1900	1897	1895	1892	1890	1887
	30	1903	1901	1898	1895	1893	1890	1887	1885	1883	1880	1878	1875

Table C. Cor. for Sec. of Par. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	3
8	2
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	3
9	1

S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	7
6	5
7	4
8	3
9	2

Ap. alt ☽ cent.		☽'s Horizontal Parallax.								Table A. Prop. part for Sec. of Paral. Add.											Tab. B. For Miles of alt. Add.	
D	M	54′	55′	56′	57′	58′	59′	60′	61′	S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	M	S
17	0	10.11	9.14	8.17	7.19	6.22	5.24	4.27	3.30	0	56	55	54	53	52	51	50	49	48	47	0	0
	10	10.12	9.15	8.18	7.20	6.23	5.26	4.28	3.31	10	46	46	45	44	43	42	41	40	39	38	1	0
																					2	0
	20	10.13	9.16	8.19	7.21	6.24	5.27	4.30	3.32	20	37	36	35	34	33	32	31	30	29	28	3	0
																					4	0
	30	10.14	9.17	8.20	7.23	6.25	5.28	4.31	3.34	30	27	26	25	25	24	23	22	21	20	19	5	1
																					6	1
	40	10.15	9.18	8.21	7.24	6.27	5.29	4.32	3.35	40	18	17	16	15	14	13	12	11	10	9	7	1
																					8	1
	50	10.16	9.19	8.22	7.25	6.28	5.31	4.34	3.37	50	8	7	6	5	5	4	3	2	1	0	9	1
18	0	10.18	9.21	8.23	7.26	6.29	5.32	4.35	3.38	0	56	55	54	53	52	51	50	49	48	47	0	0
	10	10.19	9.22	8.25	7.28	6.31	5.34	4.37	3.40	10	47	46	45	44	43	42	41	40	39	38	1	0
																					2	0
	20	10.20	9.23	8.26	7.29	6.32	5.35	4.38	3.41	20	37	36	35	34	33	32	31	30	29	28	3	0
																					4	1
	30	10.22	9.25	8.28	7.31	6.34	5.37	4.40	3.43	30	28	27	26	25	24	23	22	21	20	19	5	1
																					6	1
	40	10.23	9.26	8.29	7.32	6.36	5.39	4.42	3.45	40	18	17	16	15	14	13	12	11	10	9	7	1
																					8	1
	50	10.24	9.28	8.31	7.34	6.37	5.40	4.44	3.47	50	9	8	7	6	5	4	3	2	1	0	9	1

TABLE XIX. LOGARITHMS.

☽ Hor. Paral.		Apparent Altitude of ☽'s centre.											
M	S	17° 0′	17° 10′	17° 20′	17° 30′	17° 40′	17° 50′	18° 0′	18° 10′	18° 20′	18° 30′	18° 40′	18° 50′
54	0	2471	2469	2466	2464	2462	2459	2457	2455	2452	2450	2448	2446
	10	2457	2454	2452	2449	2447	2444	2442	2440	2438	2436	2434	2431
	20	2443	2440	2438	2435	2433	2430	2428	2426	2424	2422	2420	2417
	30	2429	2426	2424	2421	2419	2416	2414	2412	2410	2408	2406	2403
	40	2415	2412	2410	2407	2405	2402	2400	2398	2396	2394	2392	2389
	50	2401	2398	2396	2393	2391	2388	2386	2384	2382	2380	2378	2375
55	0	2387	2384	2382	2379	2377	2374	2372	2370	2368	2366	2364	2361
	10	2373	2370	2368	2365	2363	2360	2358	2356	2354	2352	2350	2348
	20	2359	2356	2354	2351	2349	2346	2344	2342	2340	2338	2336	2334
	30	2345	2342	2340	2337	2335	2333	2331	2329	2326	2324	2322	2320
	40	2331	2329	2326	2324	2322	2319	2317	2315	2312	2310	2308	2306
	50	2317	2315	2312	2310	2303	2305	2303	2301	2299	2297	2295	2293
56	0	2303	2301	2298	2296	2294	2291	2289	2287	2285	2283	2281	2279
	10	2290	2287	2285	2282	2280	2278	2276	2274	2271	2269	2267	2265
	20	2276	2274	2271	2269	2267	2264	2262	2260	2258	2256	2254	2252
	30	2262	2260	2257	2255	2253	2250	2248	2246	2244	2242	2240	2238
	40	2249	2247	2244	2242	2240	2237	2235	2233	2231	2229	2227	2225
	50	2235	2233	2230	2228	2226	2223	2221	2219	2217	2215	2213	2211
57	0	2222	2220	2217	2215	2213	2210	2208	2206	2204	2202	2200	2198
	10	2208	2206	2203	2201	2199	2197	2195	2193	2190	2188	2186	2185
	20	2195	2193	2190	2188	2186	2183	2181	2179	2177	2175	2173	2171
	30	2182	2180	2177	2175	2173	2170	2168	2166	2164	2162	2160	2158
	40	2168	2166	2163	2161	2159	2157	2155	2153	2151	2149	2147	2145
	50	2155	2153	2150	2148	2146	2143	2141	2139	2137	2135	2133	2131
58	0	2142	2140	2137	2135	2133	2130	2128	2126	2124	2122	2120	2118
	10	2129	2127	2124	2122	2120	2117	2115	2113	2111	2109	2107	2105
	20	2116	2114	2111	2109	2107	2104	2102	2100	2098	2096	2094	2092
	30	2102	2100	2097	2095	2093	2091	2089	2087	2085	2083	2081	2079
	40	2089	2087	2084	2082	2080	2078	2076	2074	2072	2070	2068	2066
	50	2076	2074	2071	2069	2067	2065	2063	2061	2059	2057	2055	2053
59	0	2063	2061	2058	2056	2054	2052	2050	2048	2046	2044	2042	2040
	10	2050	2048	2046	2044	2042	2039	2037	2035	2033	2031	2029	2027
	20	2037	2035	2033	2031	2029	2026	2024	2022	2020	2018	2016	2015
	30	2025	2023	2020	2018	2016	2013	2011	2009	2007	2005	2003	2002
	40	2012	2010	2007	2005	2003	2001	1999	1997	1995	1993	1991	1989
	50	1999	1997	1994	1992	1990	1938	1986	1984	1982	1980	1978	1976
60	0	1986	1984	1981	1979	1977	1975	1973	1971	1969	1967	1965	1964
	10	1973	1971	1969	1967	1965	1962	1960	1958	1956	1954	1952	1951
	20	1961	1959	1956	1954	1952	1950	1948	1916	1944	1942	1940	1938
	30	1948	1946	1943	1941	1939	1937	1935	1933	1931	1929	1927	1926
	40	1935	1933	1931	1929	1927	1925	1923	1921	1919	1917	1915	1913
	50	1923	1921	1918	1916	1914	1912	1910	1908	1906	1904	1902	1901
61	0	1910	1908	1906	1904	1902	1899	1897	1895	1894	1892	1890	1888
	10	1898	1896	1893	1891	1889	1887	1885	1883	1881	1879	1877	1876
	20	1885	1883	1881	1879	1877	1875	1873	1871	1869	1867	1865	1863
	30	1873	1871	1868	1866	1864	1862	1860	1858	1856	1854	1852	1851

TABLE C. Cor. for Sec. of Par. Add.

S.	Cor.
0	13
1	12
2	10
3	9
4	7
5	6
6	5
7	3
8	2
9	0
S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	3
8	2
9	1
S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	6
6	5
7	4
8	3
9	1
S.	Cor.
0	13
1	12
2	10
3	9
4	8
5	7
6	5
7	4
8	3
9	2

Ap. alt.	☽ cent.	☽'s Horizontal Parallax.								Table A. Prop. part for Sec. of Paral. Add.										
D	M	54′	55′	56′	57′	58′	59′	60′	61′	S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
19	0	10.26	9.29	8.32	7.36	6.39	5.42	4.46	3.49	0	56	55	54	53	52	51	50	49	48	48
	10	10.28	9.31	8.34	7.37	6.41	5.44	4.47	3.51	10	47	46	45	44	43	42	41	40	39	38
	20	10.29	9.33	8.36	7.39	6.43	5.46	4.49	3.53	20	37	36	35	34	33	32	31	31	30	29
	30	10.31	9.34	8.38	7.41	6.45	5.48	4.51	3.55	30	28	27	26	25	24	23	22	21	20	19
	40	10.33	9.36	8.39	7.43	6.46	5.50	4.53	3.57	40	18	17	16	15	14	14	13	12	11	10
	50	10.34	9.38	8.41	7.45	6.48	5.52	4.56	3.59	50	9	8	7	6	5	4	3	2	1	0
20	0	10.37	9.41	8.44	7.48	6.51	5.55	4.59	4. 2	0	55	54	53	52	51	50	49	48	47	47
	10	10.39	9.43	8.46	7.50	6.54	5.57	5. 1	4. 5	10	46	45	44	43	42	41	40	39	38	37
	20	10.41	9.45	8.48	7.52	6.56	5.59	5. 3	4. 7	20	36	35	34	33	33	32	31	30	29	28
	30	10.43	9.47	8.50	7.54	6.58	6. 2	5. 5	4. 9	30	27	26	25	24	23	22	21	20	19	18
	40	10.45	9.49	8.52	7.56	7. 0	6. 4	5. 8	4.12	40	17	17	16	15	14	13	12	11	10	9
	50	10.47	9.51	8.55	7.59	7. 2	6. 6	5.10	4.14	50	8	7	6	5	4	3	2	2	1	0

Tab. B. For Miles of alt. Add.

M	S
1	0
2	0
3	0
4	1
5	1
6	1
7	1
8	1
9	2
0	0
1	0
2	0
3	1
4	1
5	1
6	1
7	2
8	2
9	2

TABLE XIX. LOGARITHMS.

Apparent Altitude of ☽'s centre.

☽ Hor. Paral. M	S	19° 0′	19° 10′	19° 20′	19° 30′	19° 40′	19° 50′	20° 0′	20° 10′	20° 20′	20° 30′	20° 40′	20° 50′
54	0	2445	2443	2441	2439	2437	2435	2433	2431	2429	2427	2426	2424
	10	2430	2428	2427	2425	2423	2421	2419	2417	2415	2413	2412	2410
	20	2416	2414	2412	2410	2408	2407	2405	2403	2401	2399	2398	2396
	30	2402	2400	2398	2396	2394	2393	2391	2389	2387	2385	2384	2382
	40	2388	2386	2384	2382	2380	2379	2377	2375	2373	2371	2370	2368
	50	2374	2372	2370	2368	2366	2365	2363	2361	2359	2357	2356	2354
55	0	2360	2358	2357	2355	2353	2351	2349	2347	2346	2344	2342	2341
	10	2347	2345	2343	2341	2339	2337	2335	2333	2332	2330	2328	2327
	20	2333	2331	2329	2327	2325	2323	2321	2319	2318	2316	2314	2313
	30	2319	2317	2315	2313	2311	2310	2308	2306	2304	2302	2301	2299
	40	2305	2303	2301	2299	2297	2296	2294	2292	2291	2289	2287	2286
	50	2292	2290	2288	2286	2284	2282	2280	2278	2277	2275	2273	2272
56	0	2278	2276	2274	2272	2270	2269	2267	2265	2264	2262	2260	2259
	10	2264	2262	2261	2259	2257	2255	2253	2251	2250	2248	2246	2245
	20	2251	2249	2247	2245	2243	2242	2240	2238	2236	2234	2233	2231
	30	2237	2235	2233	2231	2229	2228	2226	2224	2223	2221	2219	2218
	40	2224	2222	2220	2218	2216	2215	2213	2211	2210	2208	2206	2205
	50	2210	2208	2207	2205	2203	2201	2199	2197	2196	2194	2192	2191
57	0	2197	2195	2193	2191	2189	2188	2186	2184	2183	2181	2179	2178
	10	2184	2182	2180	2178	2176	2175	2173	2171	2170	2168	2166	2165
	20	2170	2168	2167	2165	2163	2161	2159	2157	2156	2154	2152	2151
	30	2157	2155	2153	2151	2149	2148	2146	2144	2143	2141	2139	2138
	40	2144	2142	2140	2138	2136	2135	2133	2131	2130	2128	2126	2125
	50	2130	2128	2127	2125	2123	2122	2120	2118	2117	2115	2113	2112
58	0	2117	2115	2114	2112	2110	2109	2107	2105	2104	2102	2100	2099
	10	2104	2102	2101	2099	2097	2095	2093	2091	2090	2088	2087	2086
	20	2091	2089	2088	2086	2084	2082	2080	2078	2077	2075	2074	2073
	30	2078	2076	2075	2073	2071	2069	2067	2065	2064	2062	2061	2060
	40	2065	2063	2062	2060	2058	2056	2054	2052	2051	2049	2048	2047
	50	2052	2050	2049	2047	2045	2043	2041	2039	2038	2036	2035	2034
59	0	2039	2037	2036	2034	2032	2031	2029	2027	2026	2024	2022	2021
	10	2026	2024	2023	2021	2019	2018	2016	2014	2013	2011	2009	2008
	20	2014	2012	2010	2008	2006	2005	2003	2001	2000	1998	1996	1995
	30	2001	1999	1997	1995	1993	1992	1990	1988	1987	1985	1984	1983
	40	1988	1986	1985	1983	1981	1979	1977	1975	1974	1972	1971	1970
	50	1975	1973	1972	1970	1968	1967	1965	1963	1962	1960	1958	1957
60	0	1963	1961	1959	1957	1955	1954	1952	1950	1949	1947	1946	1945
	10	1950	1948	1946	1944	1942	1941	1939	1937	1936	1934	1933	1932
	20	1937	1935	1934	1932	1930	1929	1927	1925	1924	1922	1920	1919
	30	1925	1923	1921	1919	1917	1916	1914	1912	1911	1909	1908	1907
	40	1912	1910	1909	1907	1905	1904	1902	1900	1899	1897	1895	1894
	50	1900	1898	1896	1894	1892	1891	1889	1887	1886	1884	1883	1882
61	0	1887	1885	1884	1882	1880	1879	1877	1875	1874	1872	1871	1870
	10	1875	1873	1871	1869	1867	1866	1864	1862	1861	1859	1858	1857
	20	1862	1860	1859	1857	1855	1854	1852	1850	1849	1847	1846	1845
	30	1850	1848	1847	1845	1843	1842	1840	1838	1837	1835	1834	1833

Table C. Cor. for Sec. of Par. Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	6
5	5
6	4
7	2
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	0

S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

CORRECTION.

App. alt. D	☽'s cen. M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Prop. part for Seconds of Paral. Add. S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	Tab. B. For M. of alt. Add. M	S
21	0	10.49	9.53	8.57	8. 1	7. 5	6. 9	5.13	4.17	0	55	54	53	52	51	50	49	48	48	47	0 1 2 3 4 5 6 7 8 9	0 0 0 1 1 1 1 2 2 2
	10	10.51	9.55	8.59	8. 3	7. 7	6.11	5.15	4.19	10	46	45	44	43	42	41	40	39	38	37		
	20	10.53	9.57	9. 1	8. 6	7.10	6.14	5.18	4.22	20	36	35	35	34	33	32	31	30	29	28		
	30	10.55	10. 0	9. 4	8. 8	7.12	6.16	5.20	4.25	30	27	26	25	24	23	22	21	21	20	19		
	40	10.58	10. 2	9. 6	8.10	7.15	6.19	5.23	4.27	40	18	17	16	15	14	13	12	11	10	9		
	50	11. 0	10. 4	9. 9	8.13	7.17	6.22	5.26	4.30	50	8	8	7	6	5	4	3	2	1	0		
22	0	11. 2	10. 7	9.11	8.15	7.20	6.24	5.29	4.33	0	55	54	53	52	51	50	49	49	48	47	0 1 2 3 4 5 6 7 8 9	0 0 1 1 1 1 2 2 2 2
	10	11. 5	10. 9	9.14	8.18	7.22	6.27	5.31	4.36	10	46	45	44	43	42	41	40	39	38	37		
	20	11. 7	10.12	9.16	8.21	7.25	6.30	5.34	4.39	20	37	36	35	34	33	32	31	30	29	28		
	30	11.10	10.14	9.19	8.23	7.28	6.32	5.37	4.42	30	27	26	25	25	24	23	22	21	20	19		
	40	11.12	10.17	9.21	8.26	7.31	6.35	5.40	4.45	40	18	17	16	15	14	13	13	12	11	10		
	50	11.15	10.19	9.24	8.29	7.34	6.38	5.43	4.48	50	9	8	7	6	5	4	3	2	1	0		
23	0	11.18	10.23	9.28	8.33	7.37	6.42	5.47	4.52	0	54	53	52	51	50	49	48	48	47	46	0 1 2 3 4 5 6 7 8 9	0 0 1 1 1 1 2 2 2 3
	10	11.21	10.26	9.31	8.35	7.40	6.45	5.50	4.55	10	45	44	43	42	41	40	39	38	37	37		
	20	11.24	10.29	9.33	8.38	7.43	6.48	5.53	4.58	20	36	35	34	33	32	31	30	29	28	27		
	30	11.26	10.31	9.36	8.41	7.46	6.51	5.56	5. 1	30	26	26	25	24	23	22	21	20	19	18		
	40	11.29	10.34	9.39	8.44	7.49	6.54	5.59	5. 4	40	17	16	15	15	14	13	12	11	10	9		
	50	11.32	10.37	9.42	8.47	7.52	6.57	6. 3	5. 8	50	8	7	6	5	4	4	3	2	1	0		
24	0	11.35	10.40	9.45	8.50	7.55	7. 1	6. 6	5.11	0	54	53	52	51	50	49	49	48	47	46	0 1 2 3 4 5 6 7 8 9	0 0 1 1 1 2 2 2 3 3
	10	11.38	10.43	9.48	8.53	7.59	7. 4	6. 9	5.14	10	45	44	43	42	41	40	39	39	38	37		
	20	11.40	10.46	9.51	8.56	8. 2	7. 7	6.12	5.18	20	36	35	34	33	32	31	30	29	29	28		
	30	11.43	10.49	9.54	9. 0	8. 5	7.10	6.16	5.21	30	27	26	25	24	23	22	21	20	19	18		
	40	11.46	10.52	9.57	9. 3	8. 8	7.14	6.19	5.25	40	18	17	16	15	14	13	12	11	10	9		
	50	11.49	10.55	10. 0	9. 6	8.12	7.17	6.23	5.28	50	8	8	7	6	5	4	3	2	1	0		

Explanation of Table XIX.

This table consists of two parts, for finding a *correction* of the moon's distance and a *logarithm* corresponding: they are both in the same page from the beginning of the table to the altitude of 21 degrees, after which the correction is on the left hand page, and the logarithm on the right, both being found at the same opening of the book, in the following manner.

To find the correction of Table XIX.

1. Enter the table marked *Correction*, and find in the side column the moon's apparent altitude, or the altitude next less if there be any units of miles in the altitude; opposite to this and under the minutes of the moon's horizontal parallax will be the approximate correction.

2. Enter table A, abreast of the approximate correction, and find the seconds of the moon's horizontal parallax, viz. the tens of seconds at the side, and the units at the top, under the latter, and opposite the former will be the correction of table A.

3. Enter table B, abreast of the approximate correction, and find the units of miles in the moon's apparent altitude (neglected above) opposite to which will be a number of seconds, which being added to the corrections found from table XIX. and from table A, will give the sought correction.

To find the Logarithm of Table XIX.

Enter the table marked *Logarithms*, in the column titled at the top with the degrees and minutes *nearest* to the moon's apparent altitude, and find the logarithm corresponding to the moon's horizontal parallax in the side column, or the next less parallax if there be units of seconds in it. Abreast of this in the table C, opposite the units of seconds of parallax neglected, will be a correction, to be added to the former logarithm, to obtain the logarithm sought.

It was observed in a former part of this work that in fixing these tables so as to render the corrections of the tables A, B, C, additive, it had been found necessary to make the greatest corrections correspond to 0″ of parallax and 0′ of altitude, so that *when you find the exact parallax and altitude in the side and top columns of table XIX. it will still be necessary to refer to the tables A, B, or C, to take out the corrections corresponding to 0″ of parallax or 0′ of altitude.* This is evident from the inspection of the tables, but it was proper to make this remark as a caution to prevent mistakes. To illustrate these rules, the following examples are given, in which all the corrections are put down and added together, but after a little practice it will be very easy to take the numbers from the table by inspection, and add them together without the trouble of writing them down separately.

LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 21° 0′	21° 20′	21° 40′	22° 0′	22° 20′	22° 40′	23° 0′	23° 20′	23° 40′	24° 0′	24° 20′	24° 40′
54	0	2422	2419	2416	2413	2410	2407	2404	2401	2399	2396	2394	2391
	10	2408	2405	2402	2399	2396	2393	2390	2387	2385	2382	2380	2377
	20	2394	2391	2388	2385	2382	2379	2376	2373	2371	2368	2366	2363
	30	2380	2377	2374	2371	2368	2365	2362	2360	2357	2355	2352	2350
	40	2366	2363	2360	2357	2354	2352	2349	2346	2344	2341	2339	2336
	50	2352	2349	2346	2343	2340	2338	2335	2332	2330	2327	2325	2322
55	0	2339	2335	2332	2329	2326	2324	2321	2318	2316	2313	2311	2308
	10	2325	2322	2319	2316	2313	2310	2307	2304	2302	2299	2297	2294
	20	2311	2308	2305	2302	2299	2296	2293	2291	2288	2286	2284	2281
	30	2297	2294	2291	2288	2285	2283	2280	2277	2275	2272	2270	2267
	40	2284	2281	2278	2275	2272	2269	2266	2263	2261	2258	2256	2253
	50	2270	2267	2264	2261	2258	2256	2253	2250	2248	2245	2243	2240
56	0	2257	2253	2250	2247	2244	2242	2239	2236	2234	2231	2229	2226
	10	2243	2240	2237	2234	2231	2229	2226	2223	2221	2218	2216	2213
	20	2229	2226	2223	2220	2217	2215	2212	2210	2207	2205	2203	2200
	30	2216	2213	2210	2207	2204	2202	2199	2196	2194	2191	2189	2186
	40	2203	2200	2197	2194	2191	2188	2185	2183	2180	2178	2176	2173
	50	2189	2186	2183	2180	2177	2175	2172	2170	2167	2165	2163	2160
57	0	2176	2173	2170	2167	2164	2162	2159	2156	2154	2151	2149	2146
	10	2163	2160	2157	2154	2151	2149	2146	2143	2141	2138	2136	2133
	20	2149	2146	2144	2141	2138	2135	2132	2130	2128	2125	2123	2120
	30	2136	2133	2130	2127	2124	2122	2119	2117	2115	2112	2110	2107
	40	2123	2120	2117	2114	2111	2109	2106	2104	2101	2099	2097	2094
	50	2110	2107	2104	2101	2098	2096	2093	2091	2088	2086	2084	2081
58	0	2097	2094	2091	2088	2085	2083	2080	2078	2075	2073	2071	2068
	10	2084	2081	2078	2075	2072	2070	2067	2065	2062	2060	2058	2055
	20	2071	2068	2065	2062	2059	2057	2054	2052	2049	2047	2045	2042
	30	2058	2055	2052	2049	2046	2044	2041	2039	2036	2034	2032	2029
	40	2045	2042	2039	2036	2033	2031	2028	2026	2023	2021	2019	2016
	50	2032	2029	2026	2023	2020	2018	2015	2013	2010	2008	2006	2003
59	0	2019	2016	2013	2010	2008	2006	2003	2000	1998	1995	1993	1991
	10	2006	2003	2001	1998	1995	1993	1990	1987	1985	1982	1980	1978
	20	1993	1990	1938	1985	1982	1980	1977	1975	1972	1970	1968	1965
	30	1981	1978	1975	1972	1969	1967	1964	1962	1959	1957	1955	1953
	40	1968	1965	1962	1959	1957	1954	1952	1949	1947	1944	1942	1940
	50	1955	1952	1950	1947	1944	1942	1939	1937	1934	1932	1930	1927
60	0	1943	1940	1937	1934	1931	1929	1926	1924	1921	1919	1917	1915
	10	1930	1927	1925	1922	1919	1917	1914	1912	1909	1907	1905	1902
	20	1917	1914	1912	1909	1906	1904	1901	1899	1896	1894	1892	1890
	30	1905	1902	1900	1897	1894	1892	1889	1887	1884	1882	1880	1877
	40	1892	1889	1887	1884	1881	1879	1876	1874	1871	1869	1867	1865
	50	1880	1877	1875	1872	1869	1867	1864	1862	1859	1857	1855	1853
61	0	1868	1865	1862	1859	1857	1854	1852	1850	1847	1845	1843	1840
	10	1855	1852	1850	1847	1844	1842	1839	1837	1834	1832	1830	1828
	20	1843	1840	1838	1835	1832	1830	1827	1825	1822	1820	1818	1816
	30	1831	1828	1825	1822	1820	1817	1815	1813	1810	1808	1806	1803

TABLE C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	6
5	5
6	4
7	2
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	0

S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. D	☽'s cent M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	TABLE A. Proportional part for Seconds of Parallax. Add. S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	Tab. B For M of alt. Add. M	S.
25	0	11.53	10.59	10. 5	9.10	8.16	7.22	6.27	5.33	0	53	52	51	50	49	48	48	47	46	45	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 3 3
	10	11.57	11. 2	10. 8	9.14	8.19	7.25	6.31	5.36	10	44	43	42	41	40	39	39	38	37	36		
	20	12. 0	11. 5	10.11	9.17	8.23	7.28	6.34	5.40	20	35	34	33	32	31	30	30	29	28	27		
	30	12. 3	11. 9	10.15	9.20	8.26	7.32	6.38	5.44	30	26	25	24	23	22	21	20	20	19	18		
	40	12. 6	11.12	10.18	9.24	8.30	7.36	6.41	5.47	40	17	16	15	14	13	12	11	11	10	9		
	50	12. 9	11.15	10.21	9.27	8.33	7.39	6.45	5.51	50	8	7	6	5	4	3	2	1	1	0		
26	0	12.13	11.19	10.25	9.31	8.37	7.43	6.49	5.55	0	53	52	51	50	49	49	48	47	46	45	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 3 3
	10	12.16	11.22	10.28	9.34	8.40	7.47	6.53	5.59	10	44	43	42	41	40	40	39	38	37	36		
	20	12.19	11.25	10.32	9.38	8.44	7.50	6.56	6. 3	20	35	34	33	32	32	31	30	29	28	27		
	30	12.23	11.29	10.35	9.41	8.48	7.54	7. 0	6. 7	30	26	25	24	23	23	22	21	20	19	18		
	40	12.26	11.32	10.39	9.45	8.51	7.58	7. 4	6.11	40	17	16	15	14	14	13	12	11	10	9		
	50	12.29	11.36	10.42	9.49	8.55	8. 2	7. 8	6.15	50	8	7	6	6	5	4	3	2	1	0		
27	0	12.34	11.40	10.47	9.53	9. 0	8. 6	7.13	6.20	0	52	51	50	49	48	48	47	46	45	44	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 3 3
	10	12.37	11.44	10.51	9.57	9. 4	8.10	7.17	6.24	10	43	42	41	40	40	39	38	37	36	35		
	20	12.41	11.48	10.54	10. 1	9. 8	8.14	7.21	6.28	20	34	33	33	32	31	30	29	28	27	26		
	30	12.44	11.51	10.58	10. 5	9.11	8.18	7.25	6.32	30	25	24	24	23	22	21	20	19	18	17		
	40	12.48	11.55	11. 2	10. 9	9.15	8.22	7.29	6.36	40	17	16	15	14	13	12	11	10	9	9		
	50	12.52	11.59	11. 5	10.12	9.19	8.26	7.33	6.40	50	8	7	6	5	4	3	2	1	1	0		
28	0	12.55	12. 2	11. 9	10.16	9.23	8.30	7.37	6.44	0	52	51	50	49	48	48	47	46	45	44	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 3 4
	10	12.59	12. 6	11.13	10.20	9.27	8.34	7.42	6.49	10	43	42	41	41	40	39	38	37	36	35		
	20	13. 3	12.10	11.17	10.24	9.31	8.39	7.46	6.53	20	34	34	33	32	31	30	29	28	27	26		
	30	13. 6	12.14	11.21	10.28	9.36	8.43	7.50	6.57	30	26	25	24	23	22	21	20	19	19	18		
	40	13.10	12.18	11.25	10.32	9.40	8.47	7.54	7. 2	40	17	16	15	14	13	12	12	11	10	9		
	50	13.14	12.22	11.29	10.36	9.44	8.51	7.59	7. 6	50	8	7	6	5	5	4	3	2	1	0		
29	0	13.19	12.26	11.34	10.42	9.49	8.57	8. 4	7.12	0	51	50	49	48	48	47	46	45	44	43	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 4 4
	10	13.23	12.30	11.38	10.46	9.53	9. 1	8. 8	7.16	10	42	41	41	40	39	38	37	36	35	34		
	20	13.27	12.34	11.42	10.50	9.57	9. 5	8.13	7.21	20	34	33	32	31	30	29	28	27	27	26		
	30	13.31	12.38	11.46	10.54	10. 2	9.10	8.17	7.25	30	25	24	23	22	21	21	20	19	18	17		
	40	13.35	12.43	11.50	10.58	10. 6	9.14	8.22	7.30	40	16	15	14	14	13	12	11	10	9	8		
	50	13.39	12.47	11.55	11. 3	10.10	9.18	8.26	7.34	50	7	7	6	5	4	3	2	1	0	0		

EXAMPLE I.

Given the moon's apparent altitude 44° 27′, and her horizontal parallax 56′ 55″. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. 44° 20′ and par. 56′ is	19′ 54″
. . Tab. A. 55″ parallax . . .	3
. . Tab. B. 7′ altitude . . .	5
Sought correction . .	20′ 2″

For the Logarithm.

In Tab.xix.to nearest alt.44½° and par.56′ 50″	2088
. . Tab. C. 5″ parallax . .	5
Sought logarithm . . .	2093

EXAMPLE II.

Given the moon's apparent altitude 50° 16′, and horizontal parallax 59′ 0″. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. 50° 10′ and par. 59′ is	22′ 3″
. . Tab. A. 0″ parallax . . .	38
. . Tab. B. 6′ altitude . . .	4
Sought correction . . .	22′45″

For the Logarithm.

In Tab. xix. to alt. 50° and par. 59′ 0″	1913
. . Tab. C. 0″ parallax . . .	12
Sought logarithm . . .	1925

EXAMPLE III.

Given the moon's apparent altitude 28° 27′, and horizontal parallax 54′ 10″. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. 28° 20′ and par. 54′ is	13′ 3″
. . Tab. A 10″ parallax . . .	43
. . Tab. B. 7′ altitude . . .	3
Sought correction . .	13′49″

For the Logarithm.

Tab.xix.to nearest alt.28° 30′ and par.54′ 10″	2354
Table C. 0″ parallax . . .	12
Sought logarithm . . .	2366

LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 25° 0′	25° 20′	25° 40′	26° 0′	26° 20′	26° 40′	27° 0′	27° 30′	28° 0′	28° 30′	29° 0′	29° 30′
54	0	2389	2387	2384	2382	2380	2378	2376	2374	2371	2368	2365	2362
	10	2375	2373	2371	2369	2367	2364	2362	2360	2357	2354	2351	2348
	20	2361	2359	2357	2355	2353	2351	2349	2346	2343	2341	2338	2335
	30	2347	2345	2343	2341	2339	2337	2335	2332	2329	2327	2324	2321
	40	2334	2332	2329	2327	2325	2323	2321	2318	2315	2313	2310	2307
	50	2320	2318	2315	2313	2311	2309	2307	2304	2301	2299	2296	2293
55	0	2306	2304	2301	2299	2297	2295	2293	2291	2288	2286	2283	2280
	10	2292	2290	2288	2286	2284	2282	2280	2277	2274	2272	2269	2266
	20	2279	2277	2274	2272	2270	2268	2266	2264	2261	2258	2255	2253
	30	2265	2263	2261	2259	2257	2255	2253	2250	2247	2245	2242	2239
	40	2251	2249	2247	2245	2243	2241	2239	2236	2233	2231	2228	2226
	50	2238	2236	2234	2232	2230	2228	2226	2223	2220	2218	2215	2213
56	0	2224	2222	2220	2218	2216	2214	2212	2210	2207	2205	2202	2199
	10	2211	2209	2207	2205	2203	2201	2199	2196	2193	2191	2188	2185
	20	2198	2196	2193	2191	2189	2187	2185	2183	2180	2178	2175	2172
	30	2184	2182	2180	2178	2176	2174	2172	2170	2167	2165	2162	2159
	40	2171	2169	2167	2165	2163	2161	2159	2156	2153	2151	2148	2146
	50	2158	2156	2153	2151	2149	2147	2146	2143	2140	2138	2135	2132
57	0	2144	2142	2140	2138	2136	2134	2132	2130	2127	2125	2122	2119
	10	2131	2129	2127	2125	2123	2121	2119	2117	2114	2112	2109	2106
	20	2118	2116	2114	2112	2110	2108	2106	2104	2101	2099	2096	2093
	30	2105	2103	2101	2099	2097	2095	2093	2091	2088	2086	2083	2080
	40	2092	2090	2088	2086	2084	2082	2080	2078	2075	2073	2070	2067
	50	2079	2077	2075	2073	2071	2069	2067	2065	2062	2059	2057	2054
58	0	2066	2064	2062	2060	2058	2056	2054	2052	2049	2046	2044	2041
	10	2053	2051	2049	2047	2045	2043	2041	2039	2036	2033	2031	2028
	20	2040	2038	2036	2034	2032	2030	2028	2026	2023	2020	2018	2015
	30	2027	2025	2023	2021	2019	2017	2015	2013	2010	2007	2005	2003
	40	2014	2012	2010	2008	2006	2005	2003	2000	1997	1994	1992	1990
	50	2001	1999	1997	1995	1993	1992	1990	1987	1984	1982	1980	1977
59	0	1989	1987	1985	1983	1981	1979	1977	1975	1972	1969	1967	1964
	10	1976	1974	1972	1970	1968	1966	1964	1962	1959	1956	1954	1952
	20	1963	1961	1959	1957	1955	1954	1952	1949	1946	1944	1942	1939
	30	1951	1949	1947	1945	1943	1941	1939	1937	1934	1931	1929	1927
	40	1938	1936	1934	1932	1930	1928	1926	1924	1921	1918	1916	1914
	50	1925	1923	1921	1919	1917	1916	1914	1912	1909	1906	1904	1902
60	0	1913	1911	1909	1907	1905	1903	1901	1899	1896	1893	1891	1889
	10	1900	1898	1896	1894	1892	1891	1889	1887	1884	1881	1879	1877
	20	1888	1886	1884	1882	1880	1878	1876	1874	1871	1869	1867	1864
	30	1875	1873	1871	1869	1867	1866	1864	1862	1859	1856	1854	1852
	40	1863	1861	1859	1857	1855	1854	1852	1849	1846	1844	1842	1839
	50	1851	1849	1847	1845	1343	1841	1839	1837	1834	1832	1830	1827
61	0	1838	1836	1834	1832	1830	1829	1827	1825	1822	1819	1817	1815
	10	1826	1824	1822	1820	1818	1817	1815	1813	1810	1807	1805	1803
	20	1814	1812	1810	1808	1806	1805	1803	1800	1797	1795	1793	1791
	30	1801	1799	1798	1796	1794	1792	1790	1788	1785	1783	1781	1778

TABLE C.
Cor. for Seconds of Parallax.
Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	6
5	5
6	4
7	2
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	0

S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

CORRECTION.

Ap. alt. D	☽'s cen. M	☽'s Horizontal Parallax 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Proportional part for Seconds of Parallax. Add. S.	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
50	0	13.43	12.51	11.59	11. 7	10.15	9.23	8.31	7.39	0	51	50	49	48	48	47	46	45	44	43
	10	13.47	12.55	12. 3	11.11	10.19	9.27	8.35	7.44	10	42	42	41	40	39	38	37	36	35	35
	20	13.51	12.59	12. 7	11.16	10.24	9.32	8.40	7.48	20	34	33	32	31	30	29	29	28	27	26
	30	13.55	13. 3	12.12	11.20	10.29	9.37	8.45	7.53	30	25	24	23	23	22	21	20	19	18	17
	40	13.59	13. 8	12.16	11.24	10.33	9.41	8.49	7.58	40	17	16	15	14	13	12	11	10	10	9
	50	14. 3	13.12	12.20	11.29	10.37	9.46	8.54	8. 3	50	8	7	6	5	4	4	3	2	1	0
51	0	14. 9	13.17	12.26	11.34	10.43	9.51	9. 0	8. 9	0	50	49	48	47	47	46	45	44	43	42
	10	14.13	13.22	12.30	11.39	10.47	9.56	9. 5	8.13	10	41	41	40	39	38	37	36	35	35	34
	20	14.17	13.26	12.35	11.43	10.52	10. 1	9.10	8.18	20	33	32	31	30	30	29	28	27	26	25
	30	14.21	13.30	12.39	11.48	10.57	10. 6	9.14	8.23	30	24	24	23	22	21	20	19	18	18	17
	40	14.26	13.35	12.44	11.53	11. 2	10.10	9.19	8.28	40	16	15	14	13	12	12	11	10	9	8
	50	14.30	13.39	12.48	11.57	11. 6	10.15	9.24	8.33	50	7	6	6	5	4	3	2	1	0	0
52	0	14.35	13.44	12.53	12. 2	11.11	10.20	9.29	8.38	0	50	49	48	47	47	46	45	44	43	42
	10	14.39	13.48	12.57	12. 7	11.16	10.25	9.34	8.43	10	42	41	40	39	38	37	36	36	35	34
	20	14.43	13.53	13 2	12.11	11.21	10.30	9.39	8.48	20	33	32	31	31	30	29	28	27	26	26
	30	14.48	13.57	13. 7	12.16	11.25	10.35	9.44	8.54	30	25	24	23	22	21	20	20	19	18	17
	40	14.52	14. 2	13.11	12.21	11.30	10.40	9.49	8.59	40	16	15	15	14	13	12	11	10	9	9
	50	14.57	14. 7	13.16	12.26	11.35	10.45	9.54	9. 4	50	8	7	6	5	4	4	3	2	1	0
53	0	15. 2	14.12	13.22	12.31	11.41	10.51	10. 1	9.10	0	49	48	47	46	46	45	44	43	42	41
	10	15. 7	14.17	13.27	12.36	11.46	10.56	10. 6	9.15	10	41	40	39	38	37	36	36	35	34	33
	20	15.12	14.22	13.31	12.41	11.51	11. 1	10.11	9.21	20	32	31	31	30	29	28	27	26	26	25
	30	15.16	14.26	13.36	12.46	11.56	11. 6	10.16	9.26	30	24	23	22	21	21	20	19	18	17	16
	40	15.21	14.31	13.41	12.51	12. 1	11.11	10.21	9.31	40	16	15	14	13	12	11	11	10	9	8
	50	15.26	14.36	13.46	12.56	12. 6	11.17	10.27	9.37	50	7	6	6	5	4	3	2	1	1	0
54	0	15.31	14.41	13.51	13. 1	12.11	11.22	10.32	9.42	0	49	48	47	47	46	45	44	43	42	42
	10	15.35	14.46	13.56	13. 6	12.17	11.27	10.37	9.48	10	41	40	39	38	37	37	36	35	34	33
	20	15.40	14.50	14. 1	13.11	12.22	11.32	10.43	9.53	20	32	32	31	30	29	28	28	27	26	25
	30	15.45	14.55	14. 6	13.16	12.27	11.38	10.48	9.59	30	24	23	23	22	21	20	19	18	18	17
	40	15.50	15. 0	14.11	13.22	12.32	11.43	10.54	10. 4	40	16	15	14	14	13	12	11	10	9	9
	50	15.55	15. 5	14.16	13.27	12.38	11.48	10.59	10.10	50	8	7	6	5	4	4	3	2	1	0
55	0	16. 0	15.11	14.22	13 33	12.44	11.55	11. 5	10.16	0	48	47	46	46	45	44	43	42	41	41
	10	16. 5	15.16	14.27	13.38	12.49	12. 0	11.11	10.22	10	40	39	38	37	37	36	35	34	33	33
	20	16.10	15.21	14.32	13.43	12.54	12. 6	11.17	10.28	20	32	31	30	29	28	28	27	26	25	24
	30	16.15	15.26	14.38	13.49	13. 0	12.11	11.22	10.33	30	24	23	22	21	20	19	19	18	17	16
	40	16.20	15.32	14.43	13.54	13. 5	12.17	11.28	10.39	40	15	15	14	13	12	11	11	10	9	8
	50	16.25	15.37	14.48	13.59	13.11	12.22	11.33	10.45	50	7	6	6	5	4	3	2	2	1	0

Tab. B. For M of alt. Add.

Ap. alt. D	M	S
50	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 4 4
51	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 4 4
52	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 4 4
53	0 1 2 3 4 5 6 7 8 9	0 0 1 1 2 2 3 3 4 4
54	0 1 2 3 4 5 6 7 8 9	0 1 1 2 2 3 3 4 4 5
55	0 1 2 3 4 5 6 7 8 9	0 1 1 2 2 3 3 4 4 5

EXAMPLE IV.

Given the moon's apparent altitude 76° 36′ and her horizontal parallax 56′ 18″. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. 76° 30′ and par. 56′ is	46′ 37″
.. Tab. A. 18″ parallax	10
.. Tab. B. 6′ altitude	6
Sought correction	46′ 53″

For the Logarithm.

In Tab. xix. to nearest alt. 77° and par. 56′ 10″	2110
.. Tab. C. 8″ parallax	2
Sought logarithm	2112

EXAMPLE V.

Given the moon's apparent altitude 16° 25′ and her horizontal parallax 58′ 45″. Required the correction and logarithm?

For the Correction.

In Tab. xix. to alt. 16° 20′ and par. 58′ is	6′ 17″
.. Tab. A. 45″ parallax	14
.. Tab. B. 5′ altitude	0
Sought correction	6′ 31″

For the Logarithm.

Tab. xix. to nearest alt. 16° 20′ and par. 58′ 40″ is	2099
Tab. C. 5″ parallax	6
Sought logarithm	2105

LOGARITHMS.

☽'s Hor. Parallax.		Apparent Altitude of ☽'s centre.											
M	S	30°	30½°	31°	31½°	32°	32½°	33°	33½°	34°	34½°	35°	35½°
54	0	2360	2358	2356	2354	2352	2349	2347	2345	2344	2342	2340	2338
	10	2346	2344	2342	2340	2338	2336	2334	2332	2330	2328	2326	2324
	20	2333	2330	2328	2326	2324	2322	2320	2318	2316	2314	2313	2311
	30	2319	2316	2314	2312	2310	2308	2306	2304	2302	2300	2299	2297
	40	2305	2302	2300	2298	2296	2294	2292	2290	2289	2287	2285	2283
	50	2291	2289	2287	2285	2283	2281	2279	2277	2275	2274	2272	2270
55	0	2278	2275	2273	2271	2269	2267	2265	2263	2262	2260	2258	2256
	10	2264	2262	2260	2258	2256	2254	2252	2250	2248	2246	2245	2243
	20	2251	2248	2246	2244	2242	2240	2238	2236	2234	2232	2231	2229
	30	2237	2235	2233	2231	2229	2227	2225	2223	2221	2219	2218	2216
	40	2224	2221	2219	2217	2215	2213	2211	2209	2208	2206	2204	2202
	50	2211	2208	2206	2204	2202	2200	2198	2196	2194	2192	2191	2189
56	0	2197	2194	2192	2190	2188	2186	2184	2182	2181	2179	2177	2175
	10	2183	2181	2179	2177	2175	2173	2171	2169	2168	2166	2164	2162
	20	2170	2168	2166	2164	2162	2160	2158	2156	2154	2152	2151	2149
	30	2157	2155	2153	2150	2148	2146	2145	2143	2141	2139	2138	2136
	40	2144	2141	2139	2137	2135	2133	2131	2129	2128	2126	2124	2122
	50	2130	2128	2126	2124	2122	2120	2118	2116	2115	2113	2111	2109
57	0	2117	2115	2113	2111	2109	2107	2105	2103	2102	2100	2098	2096
	10	2104	2102	2100	2098	2096	2094	2092	2090	2089	2087	2085	2083
	20	2091	2089	2087	2085	2083	2081	2079	2077	2076	2074	2072	2070
	30	2078	2076	2074	2072	2070	2068	2066	2064	2063	2061	2059	2057
	40	2065	2063	2061	2059	2057	2055	2053	2051	2050	2048	2046	2044
	50	2052	2050	2048	2046	2044	2042	2040	2038	2037	2035	2033	2031
58	0	2039	2037	2035	2033	2031	2029	2027	2025	2024	2022	2020	2018
	10	2026	2024	2022	2020	2018	2516	2014	2013	2011	2009	2008	2006
	20	2013	2011	2009	2007	2005	2003	2002	2000	1998	1996	1995	1993
	30	2001	1998	1996	1994	1993	1991	1989	1987	1985	1983	1982	1980
	40	1988	1986	1984	1982	1980	1978	1976	1974	1973	1971	1969	1967
	50	1975	1973	1971	1969	1967	1965	1963	1961	1960	1958	1957	1955
59	0	1962	1960	1958	1956	1954	1952	1951	1949	1947	1945	1944	1942
	10	1950	1948	1946	1944	1942	1940	1938	1936	1935	1933	1931	1930
	20	1937	1935	1933	1931	1929	1927	1925	1923	1922	1920	1919	1917
	30	1925	1923	1921	1919	1917	1915	1913	1911	1910	1908	1906	1904
	40	1912	1910	1908	1906	1904	1902	1900	1898	1897	1895	1894	1892
	50	1900	1898	1896	1894	1892	1890	1888	1886	1885	1883	1881	1880
60	0	1887	1885	1883	1881	1879	1877	1875	1873	1872	1870	1869	1867
	10	1875	1873	1871	1869	1867	1865	1863	1861	1860	1858	1857	1855
	20	1862	1860	1858	1856	1854	1852	1851	1849	1847	1845	1844	1842
	30	1850	1848	1846	1844	1842	1840	1838	1836	1835	1833	1832	1830
	40	1837	1835	1833	1831	1830	1828	1826	1824	1823	1821	1820	1818
	50	1825	1823	1821	1819	1817	1815	1814	1812	1811	1809	1807	1806
61	0	1813	1811	1809	1807	1805	1803	1802	1800	1798	1796	1795	1793
	10	1801	1799	1797	1795	1793	1791	1789	1787	1786	1784	1783	1781
	20	1789	1787	1785	1783	1781	1779	1777	1775	1774	1772	1771	1769
	30	1776	1774	1772	1770	1769	1767	1765	1763	1762	1760	1759	1757

TABLE C.
Cor. for Seconds of Parallax.
Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	2
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	1

S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cen. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Prop. part for Seconds of Paral. Add. S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
36	0	16.31	15.43	14.54	14. 6	13.17	12.29	11.40	10.51	0	47	46	45	45	44	43	42	41	41	40
	10	16.36	15.48	15. 0	14.11	13.23	12.34	11.46	10.57	10	39	38	37	37	36	35	34	33	33	32
	20	16.42	15.53	15. 5	14.17	13.28	12.40	11.51	11. 3	20	31	30	29	28	28	27	26	25	24	24
	30	16.47	15.58	15.10	14.22	13.34	12.45	11.57	11. 9	30	23	22	21	20	20	19	18	17	16	16
	40	16.52	16. 4	15.16	14.27	13.39	12.51	12. 3	11.15	40	15	14	13	12	12	11	10	9	8	8
	50	16.57	16. 9	15.21	14.33	13.45	12.57	12. 9	11.21	50	7	6	5	4	4	3	2	1	0	0
37	0	17. 2	16.14	15.26	14.38	13.50	13. 3	12.15	11.27	0	47	46	45	45	44	43	42	41	41	40
	10	17. 7	16.20	15.32	14.44	13.56	13. 8	12.20	11.33	10	39	38	37	37	36	35	34	34	33	32
	20	17.13	16.25	15.37	14.50	14. 2	13.14	12.26	11.39	20	31	30	30	29	28	27	26	26	25	24
	30	17.18	16.30	15.43	14.55	14. 8	13.20	12.32	11.45	30	23	22	22	21	20	19	18	18	17	16
	40	17.23	16.36	15.48	15. 1	14.13	13.26	12.38	11.51	40	15	14	14	13	12	11	10	10	9	8
	50	17.29	16.41	15.54	15. 6	14.19	13.32	12.44	11.57	50	7	7	6	5	4	3	3	2	1	0
38	0	17.35	16.48	16. 0	15.13	14.26	13.38	12.51	12. 4	0	46	45	44	44	43	42	41	41	40	39
	10	17.40	16.53	16. 6	15.19	14.32	13.44	12.57	12.10	10	38	37	37	36	35	34	33	33	32	31
	20	17.46	16.59	16.12	15.25	14.37	13.50	13. 3	12.16	20	30	30	29	28	27	26	26	25	24	23
	30	17.51	17. 4	16.17	15.30	14.43	13.56	13. 9	12.22	30	22	22	21	20	19	19	18	17	16	15
	40	17.57	17.10	16.23	15.36	14.49	14. 2	13.15	12.29	40	15	14	13	12	12	11	10	9	8	8
	50	18. 2	17.15	16.29	15.42	14.55	14 8	13.22	12.35	50	7	6	5	4	4	3	2	1	1	0
39	0	18. 8	17.21	16.34	15.48	15. 1	14.14	13.28	12.41	0	46	45	44	44	43	42	41	41	40	39
	10	18.13	17.27	16.40	15.54	15. 7	14.20	13.34	12.47	10	38	37	37	36	35	34	34	33	32	31
	20	18.19	17.32	16.46	15.59	15.13	14.27	13.40	12.54	20	31	30	29	28	27	27	26	25	24	24
	30	18.24	17.38	16.52	16. 5	15.19	14.33	13.46	13. 0	30	23	22	21	20	20	19	18	17	17	16
	40	18.30	17.44	16.57	16.11	15.25	14.39	13.53	13. 6	40	15	14	14	13	12	11	10	10	9	8
	50	18.36	17.49	17. 3	16.17	15.31	14.45	13.59	13.13	50	7	7	6	5	4	3	3	2	1	0
40	0	18.42	17.56	17.10	16.24	15.38	14.52	14. 6	13.20	0	45	44	43	43	42	41	40	40	39	38
	10	18.48	18. 2	17.16	16.30	15.44	14.59	14.13	13.27	10	37	37	36	35	34	34	33	32	31	31
	20	18.54	18. 8	17.22	16.36	15.51	15. 5	14.19	13.33	20	30	29	28	27	27	26	25	24	24	23
	30	18.59	18.14	17.28	16.42	15.57	15.11	14.25	13.40	30	22	21	21	20	19	18	18	17	16	15
	40	19. 5	18.19	17.34	16.48	16. 3	15.17	14.32	13.46	40	15	14	13	12	11	11	10	9	8	8
	50	19.11	18.25	17.40	16.55	16. 9	15.24	14.38	13.53	50	7	6	5	5	4	3	2	2	1	0
41	0	19.18	18.32	17.47	17. 2	16.16	15.31	14.46	14. 0	0	44	43	42	42	41	40	39	39	38	37
	10	19.23	18.38	17.53	17. 8	16.23	15.37	14.52	14. 7	10	36	36	35	34	33	33	32	31	30	30
	20	19.29	18.44	17.59	17.14	16.29	15.44	14.59	14.14	20	29	28	27	27	26	25	24	24	23	22
	30	19.35	18.50	18. 5	17.20	16.35	15.50	15. 5	14.20	30	21	21	20	19	18	18	17	16	15	15
	40	19.41	18.56	18.11	17.26	16.42	15.57	15.12	14.27	40	14	13	12	12	11	10	9	9	8	7
	50	19.47	19. 2	18.17	17.33	16.48	16. 3	15.19	14.34	50	6	6	5	4	3	3	2	1	0	0

Tab. B For M of alt. Add. (D)	M	S
36	0 1 2 3 4 5 6 7 8 9	0 [illegible] 6
37	0 1 2 3 4 5 6 7 8 9	0 [illegible] 5
38	0 1 2 3 4 5 6 7 8 9	0 [illegible] 5
39	0 1 2 3 4 5 6 7 8 9	0 [illegible] 5
40	0 1 2 3 4 5 6 7 8 9	0 [illegible] 6
41	0 1 2 3 4 5 6 7 8 9	0 [illegible] 6

EXAMPLE VI.

Given the moon's apparent altitude 11° 20′ and horizontal parallax 60′ 45″. Required the correction and logarithm?

To find the Correction.

In Tab. xix. to alt. 11° 20′ and par. is 60′	4′	30″
. . Tab. A. 43″ parallax . . .		16
. . Tab. B. 0′ altitude . . .		2
Sought correction . .	4′	48″

To find the Logarithm.

Tab. xix. to nearest alt. 11° 20′ and par. 60′ 40″	2052
Tab. C. 3″ parallax	9
Sought logarithm . . .	2061

EXAMPLE VII.

Given the moon's apparent altitude 8° 40′ and horizontal parallax 56′ 20″. Required the correction and logarithm?

To find the Correction.

In Tab. xix. to alt. 8° 40′ and par. 56′ is	9′	18″
. . Tab. A. 20″ parallax		38
. . Tab. B. 0′ altitude . . .		5
Sought correction	10	1″

To find the Logarithm.

Tab. xix. to nearest alt. 8° 39′ and par. 56′ 20″	2518
Tab. C. 0″ parallax	13
Sought logarithm . . .	2531

TABLE XIX.

LOGARITHMS.

☽'s Hor. Parallax.		Apparent Altitude of ☽'s centre.											
M	S	36°	36½°	37°	37½°	38°	38½°	39°	39½°	40°	40½°	41°	41½°
54	0	2337	2335	2334	2332	2331	2329	2328	2327	2326	2324	2323	2322
	10	2323	2321	2320	2318	2317	2315	2314	2313	2312	2310	2309	2308
	20	2309	2307	2306	2304	2303	2302	2301	2300	2298	2297	2296	2294
	30	2296	2294	2293	2291	2290	2288	2287	2286	2285	2283	2282	2281
	40	2282	2280	2279	2277	2276	2274	2273	2272	2271	2270	2268	2267
	50	2268	2266	2265	2264	2263	2261	2260	2258	2257	2256	2255	2254
55	0	2255	2253	2252	2250	2249	2247	2246	2245	2244	2242	2241	2240
	10	2241	2239	2238	2236	2235	2234	2233	2232	2230	2229	2228	2227
	20	2228	2226	2225	2223	2222	2220	2219	2218	2217	2215	2214	2213
	30	2214	2212	2211	2210	2209	2207	2206	2204	2203	2202	2201	2200
	40	2201	2199	2198	2196	2195	2193	2192	2191	2190	2189	2188	2186
	50	2188	2186	2185	2183	2182	2180	2179	2178	2177	2175	2174	2173
56	0	2174	2173	2171	2169	2168	2167	2166	2164	2163	2162	2161	2160
	10	2161	2159	2158	2156	2155	2153	2152	2151	2150	2149	2148	2147
	20	2148	2146	2145	2143	2142	2140	2139	2138	2137	2135	2134	2133
	30	2135	2133	2132	2130	2129	2127	2126	2125	2124	2122	2121	2120
	40	2121	2119	2118	2117	2116	2114	2113	2112	2111	2109	2108	2107
	50	2108	2106	2105	2104	2103	2101	2100	2099	2097	2096	2095	2094
57	0	2095	2093	2092	2090	2089	2088	2087	2086	2084	2083	2082	2081
	10	2082	2080	2079	2077	2076	2075	2074	2073	2071	2070	2069	2068
	20	2069	2067	2066	2064	2063	2062	2061	2060	2058	2057	2056	2055
	30	2056	2054	2053	2051	2050	2049	2048	2047	2046	2044	2043	2042
	40	2043	2041	2040	2039	2038	2036	2035	2034	2033	2031	2030	2029
	50	2030	2028	2027	2026	2025	2023	2022	2021	2020	2018	2017	2016
58	0	2017	2016	2015	2013	2012	2010	2009	2008	2007	2006	2005	2003
	10	2005	2003	2002	2000	1999	1997	1996	1995	1994	1993	1992	1991
	20	1992	1990	1989	1987	1986	1985	1984	1982	1981	1980	1979	1978
	30	1979	1977	1976	1975	1974	1973	1971	1970	1969	1967	1966	1965
	40	1966	1965	1964	1962	1961	1960	1958	1957	1956	1955	1954	1953
	50	1954	1952	1951	1949	1948	1947	1946	1944	1943	1942	1941	1940
59	0	1941	1939	1938	1937	1936	1934	1933	1932	1931	1929	1928	1927
	10	1929	1927	1926	1924	1923	1921	1920	1919	1918	1917	1916	1915
	20	1916	1914	1913	1911	1910	1909	1908	1907	1906	1904	1903	1902
	30	1903	1902	1901	1899	1898	1896	1895	1894	1893	1892	1891	1890
	40	1891	1889	1888	1886	1885	1884	1883	1882	1881	1879	1878	1877
	50	1879	1877	1876	1874	1873	1871	1870	1869	1868	1867	1866	1865
60	0	1866	1864	1863	1862	1861	1859	1858	1857	1856	1855	1854	1853
	10	1854	1852	1851	1849	1848	1847	1846	1845	1844	1843	1841	1840
	20	1841	1840	1839	1837	1836	1834	1833	1832	1831	1830	1829	1828
	30	1829	1827	1826	1825	1824	1822	1821	1820	1819	1818	1817	1816
	40	1817	1815	1814	1812	1811	1810	1809	1808	1807	1805	1804	1803
	50	1805	1803	1802	1800	1799	1798	1797	1796	1795	1793	1792	1791
61	0	1792	1791	1790	1788	1787	1785	1784	1783	1782	1781	1780	1779
	10	1780	1778	1777	1776	1775	1773	1772	1771	1770	1769	1768	1767
	20	1768	1766	1765	1764	1763	1761	1760	1759	1758	1757	1756	1755
	30	1756	1754	1753	1752	1751	1749	1748	1747	1746	1745	1744	1743

TABLE C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	2
8	1
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	2
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	1
S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cent. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Prop. part for Sec. of Par. Add. S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
42	0	19.53	19. 8	18.24	17.39	16.54	16.10	15.25	14.41	0	44	43	43	42	41	40	40	39	38	37
	10	19.59	19.14	18.30	17.45	17. 1	16.16	15.32	14.47	10	37	36	35	34	34	33	32	31	31	30
	20	20. 5	19.20	18.36	17.52	17. 7	16.23	15.39	14.54	20	29	28	28	27	26	26	25	24	23	23
	30	20.11	19.26	18.42	17.58	17.14	16.29	15.45	15. 1	30	22	21	20	20	19	18	17	17	16	15
	40	20.17	19.33	18.48	18. 4	17.20	16.36	15.52	15. 8	40	14	14	13	12	11	11	10	9	9	8
	50	20.23	19.39	18.55	18.11	17.27	16.43	15.59	15.15	50	7	6	6	5	4	3	3	2	1	0
43	0	20.30	19.46	19. 2	18.18	17.34	16.50	16. 6	15.23	0	43	42	42	41	40	39	39	38	37	36
	10	20.36	19.52	19. 8	18.25	17.41	16.57	16.13	15.30	10	36	35	34	34	33	32	31	31	30	29
	20	20.42	19.58	19.15	18.31	17.47	17. 4	16.20	15.37	20	28	28	27	26	26	25	24	23	23	22
	30	20.48	20. 5	19.21	18.38	17.54	17.11	16.27	15.44	30	21	21	20	19	18	18	17	16	15	15
	40	20.54	20.11	19.28	18.44	18. 1	17.17	16.34	15.51	40	14	13	13	12	11	10	10	9	8	7
	50	21. 0	20.17	19.34	18.51	18. 7	17.24	16.41	15.58	50	7	6	5	5	4	3	2	2	1	0
44	0	21. 6	20.25	19.41	18.58	18.15	17.32	16.49	16. 6	0	42	41	41	40	39	38	38	37	36	35
	10	21.14	20.31	19.48	19. 5	18.22	17.39	16.56	16.13	10	35	34	33	33	32	31	31	30	29	28
	20	21.20	20.37	19.54	19.11	18.28	17.46	17. 3	16.20	20	28	27	26	26	25	24	23	23	22	21
	30	21.26	20.44	20. 1	19.18	18.35	17.52	17.10	16.27	30	21	20	19	18	18	17	16	16	15	14
	40	21.33	20.50	20. 7	19.25	18.42	17.59	17.17	16.34	40	13	13	12	11	11	10	9	8	8	7
	50	21.39	20.56	20.14	19.31	18.49	18. 6	17.24	16.41	50	6	6	5	4	3	3	2	1	1	0
45	0	21.46	21. 4	20.21	19.39	18.57	18.14	17.32	16.49	0	41	40	40	39	38	37	37	36	35	35
	10	21.53	21.10	20.28	19.46	19. 3	18.21	17.39	16.57	10	34	33	33	32	31	30	30	29	28	28
	20	21.59	21.17	20.35	19.52	19.10	18.28	17.46	17. 4	20	27	26	26	25	24	23	23	22	21	21
	30	22. 5	21.23	20.41	19.59	19.17	18.35	17.53	17.11	30	20	19	19	18	17	16	16	15	14	14
	40	22.12	21.30	20.48	20. 6	19.24	18.42	18. 0	17.18	40	13	12	12	11	10	9	9	8	7	7
	50	22.18	21.36	20.55	20.13	19.31	18.49	18. 7	17.26	50	6	5	5	4	3	2	2	1	0	0
46	0	22.25	21.43	21. 1	20.20	19.38	18.56	18.15	17.33	0	41	40	40	39	38	38	37	36	35	35
	10	22.31	21.50	21. 8	20.27	19.45	19. 3	18.22	17.40	10	34	33	33	32	31	31	30	29	29	28
	20	22.38	21.56	21.15	20.33	19.52	19.11	18.29	17.48	20	27	27	26	25	24	24	23	22	22	21
	30	22.44	22. 3	21 22	20.40	19.59	19.18	18.36	17.55	30	20	20	19	18	18	17	16	15	15	14
	40	22.51	22.10	21.28	20.47	20. 6	19.25	18.44	18. 2	40	13	13	12	11	11	10	9	9	8	7
	50	22.57	22.16	21.35	20.54	20.13	19.32	18.51	18.10	50	7	6	5	4	4	3	2	2	1	0
47	0	23. 5	22.24	21.43	21. 2	20.21	19.40	18.59	18.18	0	40	39	39	38	37	37	36	35	35	34
	10	23.11	22.31	21.50	21. 9	20.28	19.47	19. 7	18.26	10	33	33	32	31	31	30	29	28	28	27
	20	23.18	22.37	21.57	21.16	20.35	19.55	19.14	18.33	20	26	26	25	24	24	23	22	22	21	20
	30	23.25	22.44	22. 4	21.23	20.43	20. 2	19.21	18.41	30	20	19	18	18	17	16	16	15	14	14
	40	23.31	22.51	22.11	21.30	20.50	20. 9	19.29	18.48	40	13	12	12	11	10	10	9	8	8	7
	50	23.38	22.58	22.18	21.37	20.57	20.17	19.36	18.56	50	6	5	5	4	3	3	2	1	1	0
48	0	23.46	23. 6	22.25	21.45	21. 5	20.25	19.45	19. 5	0	39	38	38	37	36	36	35	34	34	33
	10	23.52	23.12	22.32	21.52	21.12	20.32	19.52	19.12	10	32	32	31	30	30	29	28	28	27	26
	20	23.59	23.19	22.39	22. 0	21.20	20.40	20. 0	19.20	20	26	25	24	24	23	22	22	21	20	20
	30	24. 6	23.26	22.46	22. 7	21.27	20.47	20. 7	19.28	30	19	18	18	17	16	16	15	14	14	13
	40	24.13	23.33	22.53	22.14	21.34	20.55	20.15	19.35	40	12	12	11	10	10	9	8	8	7	6
	50	24.20	23.40	23. 1	22.21	21.42	21. 2	20.23	19.43	50	6	5	4	4	3	2	2	1	0	0
49	0	24.27	23.48	23. 9	22.29	21.50	21.10	20.31	19.52	0	38	37	37	36	35	35	34	33	33	32
	10	24.34	23.55	23.16	22.36	21.57	21.18	20.39	20. 0	10	31	31	30	30	29	28	28	27	26	26
	20	24.41	24. 2	23.23	22.44	22. 5	21.26	20.46	20. 7	20	25	24	24	23	22	22	21	20	20	19
	30	24.48	24. 9	23.30	22.51	22.12	21.33	20.54	20.15	30	18	18	17	17	16	15	15	14	13	13
	40	24.55	24.16	23.37	22.58	22.19	21.41	21. 2	20.23	40	12	11	11	10	9	9	8	7	7	6
	50	25. 2	24.23	23.44	23. 6	22.27	21.48	21. 9	20.31	50	5	5	4	4	3	2	2	1	0	0

Tab. B. For M. of alt. Add.

D	M	S
42–49 (each)	0 1 2 3 4 5 6 7 8 9	[illegible]

TABLE XIX.

LOGARITHMS.

☽'s Hor. Parallax. M	S	42°	42½°	43°	43½°	44°	44½°	45°	45½°	46°	47°	48°	49°
		Apparent Altitude of ☽'s centre.											
54	0	2321	2320	2319	2318	2317	2316	2315	2314	2313	2311	2309	2308
	10	2307	2306	2305	2304	2303	2302	2301	2300	2299	2297	2296	2294
	20	2293	2292	2291	2290	2289	2288	2287	2286	2285	2284	2282	2280
	30	2280	2279	2278	2277	2276	2275	2274	2273	2272	2270	2268	2267
	40	2266	2265	2264	2263	2262	2261	2260	2259	2258	2256	2255	2253
	50	2253	2251	2250	2249	2248	2247	2246	2246	2245	2243	2241	2240
55	0	2239	2238	2237	2236	2235	2234	2233	2232	2231	2229	2228	2226
	10	2226	2224	2223	2222	2221	2220	2219	2219	2218	2216	2214	2213
	20	2212	2211	2210	2209	2208	2207	2206	2205	2204	2203	2201	2199
	30	2199	2198	2197	2196	2195	2194	2193	2192	2191	2189	2188	2186
	40	2185	2184	2183	2182	2181	2180	2179	2179	2178	2176	2174	2173
	50	2172	2171	2170	2169	2168	2167	2166	2165	2164	2163	2161	2159
56	0	2159	2158	2157	2156	2155	2154	2153	2152	2151	2149	2148	2146
	10	2146	2144	2143	2142	2141	2140	2139	2138	2138	2136	2134	2133
	20	2132	2131	2130	2129	2128	2127	2126	2125	2125	2123	2121	2120
	30	2119	2118	2117	2116	2115	2114	2113	2112	2111	2110	2108	2107
	40	2106	2105	2104	2103	2102	2101	2100	2099	2098	2097	2095	2093
	50	2093	2092	2091	2090	2089	2088	2087	2086	2085	2084	2082	2080
57	0	2080	2079	2078	2077	2076	2075	2074	2073	2072	2071	2069	2067
	10	2067	2066	2065	2064	2063	2062	2061	2060	2059	2058	2056	2054
	20	2054	2053	2052	2051	2050	2049	2048	2047	2046	2045	2043	2042
	30	2041	2040	2039	2038	2037	2036	2035	2034	2033	2032	2030	2029
	40	2028	2027	2026	2025	2024	2023	2022	2021	2021	2019	2017	2016
	50	2015	2014	2013	2012	2011	2010	2009	2008	2008	2006	2005	2003
58	0	2002	2001	2000	1999	1998	1998	1997	1996	1995	1993	1992	1990
	10	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1979	1977
	20	1977	1976	1975	1974	1973	1972	1971	1970	1970	1968	1966	1965
	30	1964	1963	1962	1961	1960	1959	1958	1957	1957	1955	1954	1952
	40	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1941	1939
	50	1939	1938	1937	1936	1935	1934	1933	1932	1932	1930	1928	1927
59	0	1926	1925	1924	1923	1922	1922	1921	1920	1919	1917	1916	1914
	10	1914	1913	1912	1911	1910	1909	1908	1907	1906	1905	1903	1902
	20	1901	1900	1899	1898	1897	1897	1896	1895	1394	1892	1891	1889
	30	1889	1888	1887	1886	1885	1884	1883	1882	1882	1880	1878	1877
	40	1876	1875	1874	1873	1872	1872	1871	1870	1869	1867	1866	1864
	50	1864	1863	1862	1861	1860	1859	1858	1857	1857	1855	1854	1852
60	0	1852	1851	1850	1849	1848	1847	1846	1845	1844	1843	1841	1840
	10	1839	1838	1837	1836	1835	1835	1834	1833	1832	1830	1829	1827
	20	1827	1826	1825	1824	1823	1822	1821	1820	1820	1818	1817	1815
	30	1815	1814	1813	1812	1811	1810	1809	1808	1808	1806	1804	1803
	40	1802	1801	1800	1800	1799	1798	1797	1796	1795	1794	1792	1791
	50	1790	1789	1788	1787	1786	1786	1785	1784	1783	1782	1780	1779
61	0	1778	1777	1776	1775	1774	1774	1773	1772	1771	1769	1768	1766
	10	1766	1765	1764	1763	1762	1761	1760	1759	1759	1757	1756	1754
	20	1754	1753	1752	1751	1750	1749	1748	1747	1747	1745	1744	1742
	30	1742	1741	1740	1739	1738	1737	1736	1735	1735	1733	1732	1730

TABLE C.
Cor. for Seconds of Parallax. Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	2
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	1
S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

TABLE XIX.

CORRECTION.

Ap. alt. ☽ cent.		☽'s Horizontal Parallax.								TABLE A. Proport. part for Sec. of Par. Add.											Tab B For M. of Alt. Add.	
D	M	54′	55′	56′	57′	58′	59′	60′	61′	S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	M	S
50	0	25. 9	24.30	23.51	23.13	22.34	21.56	21.17	20.39	0	38	37	37	36	35	35	34	34	33	32	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	25.16	24.37	23.59	23.20	22.42	22. 3	21.25	20.47	10	32	31	30	30	29	28	23	27	27	26		
	20	25.23	24.44	24. 6	23.28	22.49	22.11	21.33	20.54	20	25	25	24	23	23	22	21	21	20	19		
	30	25.30	24.51	24.13	23.35	22.57	22.19	21.41	21. 2	30	19	18	18	17	16	16	15	14	14	13		
	40	25.37	24.59	24.21	23.42	23. 4	22.26	21.48	21.10	40	12	12	11	11	10	9	9	8	7	7		
	50	25.44	25. 6	24.28	23.50	23.12	22.34	21.56	21.18	50	6	5	5	4	4	3	2	2	1	0		
51	0	25.52	25.14	24.36	23.58	23.21	22.43	22. 5	21.27	0	37	36	36	35	35	34	33	33	32	31	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	25.59	25.21	24.43	24. 6	23.28	22.51	22.13	21.35	10	31	30	30	29	28	28	27	26	26	25		
	20	26. 6	25.28	24.51	24.13	23.36	22.58	22.21	21.43	20	25	24	23	23	22	21	21	20	20	19		
	30	26.13	25.36	24.58	24.21	23.43	23. 6	22.29	21.51	30	18	18	17	16	16	15	15	14	13	13		
	40	26.20	25.43	25. 6	24.28	23.51	23.14	22.37	21.59	40	12	11	11	10	10	9	8	8	7	6		
	50	26.27	25.50	25.13	24.36	23.59	23.22	22.45	22. 8	50	6	5	5	4	3	3	2	1	1	0		
52	0	26.35	25.58	25.21	24.44	24. 7	23.31	22.54	22.17	0	36	35	35	34	34	53	32	32	31	31	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	26.42	26. 6	25.29	24.52	24.15	23.38	23. 2	22.25	10	30	29	29	28	27	27	26	26	25	24		
	20	26.50	26.13	25.36	25. 0	24.23	23.46	23.10	22.33	20	24	23	23	22	21	21	20	20	19	18		
	30	26.57	26.20	25.44	25. 7	24.31	23.54	23.18	22.41	30	18	17	16	16	15	15	14	13	13	12		
	40	27. 4	26.28	25.51	25.15	24.39	24. 2	23.26	22.49	40	12	11	10	10	9	9	8	7	7	6		
	50	27.11	26.35	25.59	25.23	24.46	24.10	23.34	22.58	50	6	5	4	4	3	2	2	1	1	0		
53	0	27.20	26.43	26. 7	25.31	24.55	24.19	23.43	23. 7	0	35	34	34	33	33	32	31	31	30	30	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	27.27	26.51	26.15	25.39	25. 3	24.27	23.51	23.15	10	29	28	28	27	27	26	25	25	24	24		
	20	27.34	26.58	26.22	25.47	25.11	24.35	23.59	23.23	20	23	22	22	21	21	20	20	19	18	18		
	30	27.41	27. 6	26.30	25.54	25.19	24.43	24. 7	23.32	30	17	17	16	15	15	14	14	13	12	12		
	40	27.49	27.13	26.38	26. 2	25.27	24.51	24.15	23.40	40	11	11	10	9	9	8	8	7	6	6		
	50	27.56	27.21	26.45	26.10	25.34	24.59	24.24	23.48	50	5	5	4	3	3	2	2	1	0	0		
54	0	28. 4	27.29	26.54	26.19	25.43	25. 8	24.33	23.58	0	34	33	33	32	32	31	31	30	29	29	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	28.12	27.37	27. 2	26.26	25.51	25.16	24.41	24. 6	10	28	28	27	26	26	25	25	24	24	23		
	20	28.19	27.44	27. 9	26.34	25.59	25.24	24.49	24.14	20	22	22	21	21	20	19	19	18	18	17		
	30	28.27	27.52	27.17	26.42	26. 7	25.32	24.58	24.23	30	17	16	15	15	14	14	13	12	12	11		
	40	28.34	27.59	27.25	26.50	26.15	25.41	25. 6	24.31	40	11	10	10	9	8	8	7	7	6	5		
	50	28.42	28. 7	27.32	26.58	26.23	25.49	25.14	24.40	50	5	4	4	3	3	2	1	1	0	0		
55	0	28.50	28.16	27.41	27. 7	26.32	25.58	25.24	24.49	0	33	32	32	31	31	30	30	29	23	28	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	28.58	28.23	27.49	27.15	26.40	26. 6	25.32	24.58	10	27	27	26	26	25	24	24	23	23	22		
	20	29. 5	28.31	27.57	27.23	26.49	26.14	25.40	25. 6	20	22	21	21	20	19	19	18	18	17	17		
	30	29.13	28.39	28. 5	27.31	26.57	26.23	25.49	25.15	30	16	15	15	14	14	13	13	12	11	11		
	40	29.20	28.46	28.12	27.39	27. 5	26.31	25.57	25.23	40	10	10	9	9	8	7	7	6	6	5		
	50	29.28	28.54	28.20	27.47	27.13	26.39	26. 5	25.32	50	5	4	3	3	2	2	1	1	0	0		
56	0	29.35	29. 2	28.28	27.55	27.21	26.47	26.14	25.40	0	33	32	32	31	31	30	30	29	29	28	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	29.43	29. 9	28.36	28. 3	27.29	26.56	26.22	25.49	10	27	27	26	26	25	25	24	24	23	22		
	20	29.50	29.17	28.44	28.11	27.37	27. 4	26.31	25.58	20	22	21	21	20	20	19	19	18	13	17		
	30	29.58	29.25	28.52	28.19	27.46	27.12	26.39	26. 6	30	16	16	15	15	14	14	13	13	12	11		
	40	30. 6	29.33	29. 0	28.27	27.54	27.21	26.48	26.15	40	11	10	10	9	9	8	8	7	6	6		
	50	30.13	29.40	29. 8	28.35	28. 2	27.29	26.56	26.23	50	5	5	4	4	3	3	2	1	1	0		
57	0	30.22	29.49	29.17	28.44	28.11	27.39	27. 6	26.33	0	32	31	31	30	30	29	29	28	28	27	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	30.30	29.57	29.25	28.52	28.19	27.47	27.14	26.42	10	27	26	26	25	24	24	23	23	22	22		
	20	30.37	30. 5	29.33	29. 0	28.28	27.55	27.23	26.51	20	21	21	20	20	19	19	18	17	17	16		
	30	30.45	30.13	29.41	29. 8	28.36	28. 4	27.32	26.59	30	16	15	15	14	14	13	13	12	12	11		
	40	30.53	30.21	29.49	29.16	28.44	28.12	27.40	27. 8	40	10	10	9	9	8	8	7	7	6	6		
	50	31. 1	30.29	29.57	29.25	28.53	28.21	27.49	27.17	50	5	5	4	3	3	2	2	1	1	0		
58	0	31. 9	30.37	30. 6	29.34	29. 2	28.30	27.58	27.27	0	31	30	30	29	29	28	28	27	27	26	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	31.17	30.45	30.14	29.42	29.10	28.39	28. 7	27.35	10	26	25	25	24	24	23	23	22	22	21		
	20	31.25	30.53	30.22	29.50	29.19	28.47	28.16	27.44	20	21	20	19	19	18	18	17	17	16	16		
	30	31.33	31. 1	30.30	29.59	29.27	28.56	28.24	27.53	30	15	15	14	14	13	13	12	12	11	11		
	40	31.40	31. 9	30.38	30. 7	29.36	29. 4	28.33	28. 2	40	10	10	9	8	8	7	7	6	6	5		
	50	31.48	31.17	30.46	30.15	29.44	29.13	28.42	28.11	50	5	4	4	3	3	2	2	1	1	0		
59	0	31.57	31.26	30.55	30.24	29.53	29.23	28.52	28.21	0	30	29	29	28	28	27	27	26	26	25	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	32. 5	31.34	31. 3	30.33	30. 2	29.31	29. 0	28.30	10	25	24	24	23	23	22	22	21	21	20		
	20	32.13	31.42	31.12	30.41	30.10	29.40	29. 9	28.39	20	20	19	19	18	18	17	17	16	16	15		
	30	32.21	31.50	31 20	30.49	30.19	29.48	29.18	28.48	30	15	14	14	13	13	12	12	11	11	10		
	40	32.29	31.58	31.28	30.58	30 27	29.57	29.27	28.56	40	10	9	9	8	8	7	7	6	6	5		
	50	32.37	32. 6	31.36	31 6	30.36	30. 6	29.36	29. 5	50	5	4	4	3	3	2	1	1	0	0		

TABLE XIX.

LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 50°	51°	52°	53°	54°	55°	56°	57°	58°	59°
54	0	2306	2305	2303	2302	2301	2300	2298	2297	2296	2295
	10	2293	2291	2290	2288	2287	2286	2285	2284	2283	2282
	20	2279	2277	2276	2275	2274	2272	2271	2270	2269	2268
	30	2265	2264	2262	2261	2260	2259	2258	2257	2256	2254
	40	2252	2250	2249	2248	2246	2245	2244	2243	2242	2241
	50	2238	2237	2235	2234	2233	2232	2230	2230	2229	2227
55	0	2225	2223	2222	2221	2219	2218	2217	2216	2215	2214
	10	2211	2210	2208	2207	2206	2205	2204	2203	2202	2201
	20	2198	2196	2195	2194	2193	2191	2190	2189	2188	2187
	30	2184	2183	2182	2180	2179	2178	2177	2176	2175	2174
	40	2171	2170	2168	2167	2166	2165	2164	2163	2162	2161
	50	2158	2156	2155	2154	2153	2152	2150	2149	2148	2147
56	0	2145	2143	2142	2141	2139	2138	2137	2136	2135	2134
	10	2131	2130	2129	2127	2126	2125	2124	2123	2122	2121
	20	2118	2117	2116	2114	2113	2112	2111	2110	2109	2108
	30	2105	2104	2102	2101	2100	2099	2098	2097	2096	2095
	40	2092	2091	2089	2088	2087	2086	2085	2084	2083	2082
	50	2079	2078	2076	2075	2074	2073	2072	2071	2070	2069
57	0	2066	2065	2063	2062	2061	2060	2059	2058	2057	2056
	10	2053	2052	2050	2049	2048	2047	2046	2045	2044	2043
	20	2040	2039	2037	2036	2035	2034	2033	2032	2031	2030
	30	2027	2026	2025	2023	2022	2021	2020	2019	2018	2017
	40	2014	2013	2012	2010	2009	2008	2007	2006	2005	2004
	50	2002	2000	1999	1998	1997	1996	1994	1993	1992	1991
58	0	1989	1987	1986	1985	1984	1983	1982	1981	1980	1979
	10	1976	1975	1973	1972	1971	1970	1969	1968	1967	1966
	20	1963	1962	1961	1960	1958	1957	1956	1955	1954	1953
	30	1951	1949	1948	1947	1946	1945	1944	1943	1942	1941
	40	1938	1937	1936	1934	1933	1932	1931	1930	1929	1928
	50	1926	1924	1923	1922	1921	1920	1918	1917	1917	1916
59	0	1913	1912	1910	1909	1908	1907	1906	1905	1904	1903
	10	1901	1899	1898	1897	1896	1895	1893	1892	1892	1891
	20	1888	1887	1885	1884	1883	1882	1881	1880	1879	1878
	30	1876	1874	1873	1872	1871	1870	1869	1868	1867	1866
	40	1863	1862	1861	1859	1858	1857	1856	1855	1854	1853
	50	1851	1849	1848	1847	1846	1845	1844	1843	1842	1841
60	0	1838	1837	1836	1835	1834	1833	1832	1831	1830	1829
	10	1826	1825	1824	1822	1821	1820	1819	1818	1817	1816
	20	1814	1813	1811	1810	1809	1808	1807	1806	1805	1804
	30	1802	1800	1799	1798	1797	1796	1795	1794	1793	1792
	40	1789	1788	1787	1786	1785	1784	1783	1782	1781	1780
	50	1777	1776	1775	1774	1773	1771	1770	1770	1769	1768
61	0	1765	1764	1763	1761	1760	1759	1758	1757	1757	1756
	10	1753	1752	1751	1749	1748	1747	1746	1745	1744	1743
	20	1741	1740	1739	1737	1736	1735	1734	1733	1732	1731
	30	1729	1728	1727	1725	1724	1723	1722	1721	1720	1719

TABLE C. Cor. for Seconds of Parallax. Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	2
9	0
S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	1
S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	3
8	2
9	1

TABLE XIX.

CORRECTION.

Ap. alt. D	☽'s cent. M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Propor. part for Sec. of Par. Add. S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	Tab. B for M. of Alt. Add. M	S
60	0	32.45	32.15	31.45	31.15	30.45	30.15	29.45	29.15	0	29	29	28	28	27	27	26	26	25	25	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	32.53	32.24	31.54	31,24	30.54	30.24	29.54	29.24	10	24	24	23	23	22	22	21	21	20	20		
	20	33. 1	32.32	32. 2	31.32	31. 3	30.33	30. 3	29.34	20	19	19	18	18	17	17	16	16	15	15		
	30	33. 9	32.40	32.10	31.41	31.11	30.42	30.12	29.43	30	14	14	13	13	12	12	11	11	10	10		
	40	33.17	32.48	32.19	31.49	31.20	30.50	30.21	29.52	40	9	9	8	8	7	7	6	6	5	5		
	50	33.25	32.56	32.27	31.58	31.28	30.59	30.30	30. 1	50	4	4	3	3	2	2	1	1	0	0		
61	0	33.34	33. 5	32.36	32. 7	31.38	31. 9	30.40	30.11	0	28	28	27	27	26	26	25	25	24	24	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	33.42	33.14	32.45	32.16	31.47	31.18	30.49	30.20	10	23	23	22	22	21	21	20	20	19	19		
	20	33.51	33.22	32.53	32.24	31.55	31.27	30.58	30.29	20	18	18	17	17	17	16	16	15	15	14		
	30	33.59	33.30	33 1	32.33	32. 4	31.35	31. 7	30.38	30	14	13	13	12	12	11	11	10	10	9		
	40	34. 7	33.38	33.10	32.41	32.13	31.44	31.16	30.47	40	9	8	8	7	7	6	6	5	5	5		
	50	34.15	33.46	33.18	32.50	32.21	31.53	31.25	30.56	50	4	4	3	3	2	2	1	1	0	0		
62	0	34.24	33.56	33.27	32.59	32.31	32. 3	31.35	31. 7	0	27	27	26	26	25	25	24	24	23	23	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	34.32	34. 4	33.36	33. 8	32.40	32.12	31.44	31.16	10	22	22	21	21	21	20	20	19	19	18		
	20	34.40	34.12	33.44	33.17	32.49	32.21	31.53	31.25	20	18	17	17	16	16	15	15	15	14	14		
	30	34.48	34.21	33.53	33.25	32.57	32.30	32. 2	31.34	30	13	13	12	12	11	11	10	10	9	9		
	40	34.56	34.29	34. 1	33.34	33. 6	32.39	32.11	31.44	40	8	8	8	7	7	6	6	5	5	4		
	50	35. 5	34.37	34.10	33.42	33.15	32.48	32.20	31.53	50	4	3	3	2	2	2	1	1	0	0		
63	0	35.14	34.46	34.19	33.52	33.25	32.58	32.30	32. 3	0	26	26	25	25	24	24	23	23	22	22	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	35.22	34.55	34.28	34. 1	33.34	33. 7	32.39	32.12	10	22	21	21	20	20	19	19	18	18	17		
	20	35.30	35. 3	34.36	34. 9	33.42	33.16	32.49	32.22	20	17	17	16	16	15	15	14	14	13	13		
	30	35.38	35.12	34.45	34.18	33.51	33.25	32.58	32.31	30	13	12	12	11	11	10	10	9	9	9		
	40	35.47	35.20	34.53	34.27	34. 0	33.34	33. 7	32.40	40	8	8	7	7	6	6	5	5	5	4		
	50	35.55	35.28	35. 2	34.36	34. 9	33.43	33.16	32.50	50	4	3	3	2	2	1	1	0	0	0		
64	0	36. 4	35.38	35.12	34.45	34.19	33.53	33.26	33. 0	0	25	25	24	24	23	23	22	22	22	21	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	36.12	35.46	35.20	34.54	34.28	34. 2	33.36	33. 9	10	21	20	20	19	19	19	18	18	17	17		
	20	36.21	35.55	35.29	35. 3	34.37	34.11	33.45	33.19	20	16	16	16	15	15	14	14	13	13	12		
	30	36.29	36. 3	35.37	35.12	34.46	34.20	33.54	33.28	30	12	12	11	11	10	10	9	9	9	8		
	40	36.37	36.12	35.46	35.20	34.55	34.29	34. 3	33.38	40	8	7	7	6	6	6	5	5	4	4		
	50	36.46	36.20	35.55	35.29	35. 4	34.38	34.13	33.47	50	3	3	3	2	2	1	1	0	0	0		
65	0	36.55	36.30	36. 4	35.39	35.14	34.48	34.23	33.57	0	24	24	23	23	22	22	22	21	21	20	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	37. 3	36.38	36.13	35.48	35.23	34.57	34.32	34. 7	10	20	19	19	19	18	18	17	17	17	16		
	20	37.12	36.47	36.22	35.57	35.32	35. 6	34.41	34.16	20	16	15	15	14	14	14	13	13	12	12		
	30	37.20	36.55	36.30	36. 5	35.41	35.16	34.51	34.26	30	12	11	11	10	10	9	9	9	8	8		
	40	37.28	37. 4	36.39	36.14	35.50	35.25	35. 0	34.35	40	7	7	7	6	6	5	5	4	4	4		
	50	37.37	37.12	36.48	36.23	35.59	35.34	35. 9	34.45	50	3	3	2	2	2	1	1	0	0	0		
66	0	37.45	37.21	36.56	36.32	36. 8	35.43	35.19	34.54	0	24	24	23	23	22	22	22	21	21	20	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	37.54	37.29	37. 5	36.41	36.17	35.52	35.28	35. 4	10	20	20	19	19	18	18	18	17	17	16		
	20	38. 2	37.38	37.14	36.50	36.26	36. 2	35.38	35.13	20	16	16	15	15	14	14	14	13	13	12		
	30	38.11	37.47	37.23	36.59	36.35	36.11	35.47	35.23	30	12	12	11	11	10	10	10	9	9	8		
	40	38.19	37.55	37.31	37. 8	36.44	36.20	35.56	35.33	40	8	8	7	7	6	6	6	5	5	4		
	50	38.27	38. 4	37.40	37.17	36.53	36.29	36. 6	35.42	50	4	4	3	3	2	2	2	1	1	0		
67	0	38.37	38.13	37.50	37.27	37. 3	36.40	36.16	35.53	0	23	23	22	22	21	21	21	20	20	20	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	38.45	38.22	37.59	37.36	37.12	36.49	36.26	36. 2	10	19	19	18	18	18	17	17	16	16	16		
	20	38.54	38.31	38. 8	37.45	37.21	36.58	36.35	36.12	20	15	15	15	14	14	13	13	13	12	12		
	30	39. 2	38.39	38.17	37.54	37.31	37. 8	36.45	36.22	30	11	11	11	10	10	10	9	9	8	8		
	40	39.11	38.48	38.25	38. 3	37.40	37.17	36.54	36.31	40	8	7	7	6	6	6	5	5	5	4		
	50	39.19	38.57	38.34	38.12	37.49	37.26	37. 4	36.41	50	4	3	3	3	2	2	2	1	1	0		
68	0	39.29	39. 7	38.44	38.22	37.59	37.37	37.14	36.52	0	22	22	21	21	21	20	20	19	19	19	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	39.38	39.15	38.53	38.31	38. 8	37.46	37.24	37. 1	10	18	18	18	17	17	16	16	16	15	15		
	20	39.46	39.24	39. 2	38.40	38.18	37.55	37.33	37.11	20	15	14	14	14	13	13	12	12	12	11		
	30	39.55	39.33	39.11	38.49	38.27	38. 5	37.43	37.21	30	11	11	10	10	9	9	9	8	8	8		
	40	40. 3	39.41	39.20	38.58	38.36	38.14	37.52	37.30	40	7	7	7	6	6	5	5	5	4	4		
	50	40.12	39.50	39.29	39. 7	38.45	38.24	38. 2	37.40	50	4	3	3	2	2	2	1	1	1	0		
69	0	40.21	40. 0	39.38	39.17	38.55	38.34	38.12	37.51	0	21	21	20	20	20	19	19	19	18	18	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8
	10	40.30	40. 9	39.47	39.26	39. 5	38.43	38.22	38. 1	10	17	17	17	16	16	16	15	15	15	14		
	20	40.39	40.18	39.56	39.35	39.14	38.53	38.32	38.10	20	14	14	13	13	13	12	12	12	11	11		
	30	40.47	40.26	40. 5	39.44	39.23	39. 2	38.41	38.20	30	10	10	10	9	9	9	8	8	8	7		
	40	40.56	40.35	40.14	39.53	39.33	39.12	38.51	38.30	40	7	7	6	6	6	5	5	4	4	4		
	50	41. 5	40.44	40.23	40. 3	39.42	39.21	39. 1	38.40	50	3	3	3	2	2	2	1	1	1	0		

TABLE XIX.

LOGARITHMS.

☽'s Hor. Parallax. M	S	Apparent Altitude of ☽'s centre. 60°	61°	62°	63°	64°	65°	66°	67°	68°	69°
54	0	2295	2294	2293	2292	2291	2291	2290	2289	2289	2288
	10	2281	2280	2279	2278	2278	2277	2276	2276	2275	2274
	20	2267	2266	2266	2265	2264	2263	2263	2262	2261	2261
	30	2254	2253	2252	2251	2250	2250	2249	2248	2248	2247
	40	2240	2239	2238	2238	2237	2236	2236	2235	2234	2234
	50	2227	2226	2225	2224	2223	2223	2222	2221	2221	2220
55	0	2213	2212	2212	2211	2210	2209	2209	2208	2207	2207
	10	2200	2199	2198	2197	2197	2196	2195	2195	2194	2194
	20	2186	2186	2185	2184	2183	2183	2182	2181	2181	2180
	30	2173	2172	2171	2171	2170	2169	2169	2168	2167	2167
	40	2160	2159	2158	2157	2157	2156	2155	2155	2154	2154
	50	2147	2146	2145	2144	2143	2143	2142	2141	2141	2140
56	0	2133	2133	2132	2131	2130	2130	2129	2128	2128	2127
	10	2120	2119	2119	2118	2117	2116	2116	2115	2114	2114
	20	2107	2106	2105	2105	2104	2103	2103	2102	2101	2101
	30	2094	2093	2092	2092	2091	2090	2090	2089	2088	2088
	40	2081	2080	2079	2078	2078	2077	2077	2076	2075	2075
	50	2068	2067	2066	2065	2065	2064	2064	2063	2062	2062
57	0	2055	2054	2053	2053	2052	2051	2051	2050	2049	2049
	10	2042	2041	2040	2040	2039	2038	2038	2037	2036	2036
	20	2029	2028	2028	2027	2026	2025	2025	2024	2024	2023
	30	2016	2016	2015	2014	2013	2013	2012	2011	2011	2010
	40	2004	2003	2002	2001	2000	2000	1999	1999	1998	1998
	50	1991	1990	1989	1988	1988	1987	1986	1986	1985	1985
58	0	1978	1977	1976	1976	1975	1974	1974	1973	1972	1972
	10	1965	1965	1964	1963	1962	1962	1961	1960	1960	1959
	20	1953	1952	1951	1950	1950	1949	1948	1948	1947	1947
	30	1940	1939	1938	1938	1937	1936	1936	1935	1934	1934
	40	1927	1927	1926	1925	1924	1924	1923	1923	1922	1921
	50	1915	1914	1913	1912	1912	1911	1911	1910	1909	1909
59	0	1902	1902	1901	1900	1899	1899	1898	1898	1897	1896
	10	1890	1889	1888	1887	1887	1886	1886	1885	1884	1884
	20	1877	1877	1876	1875	1874	1874	1873	1873	1872	1872
	30	1865	1864	1863	1863	1862	1861	1861	1860	1860	1859
	40	1853	1852	1851	1850	1850	1849	1848	1848	1847	1847
	50	1840	1840	1839	1838	1837	1837	1836	1836	1835	1834
60	0	1828	1827	1826	1826	1825	1824	1824	1823	1823	1822
	10	1816	1815	1814	1813	1813	1812	1812	1811	1810	1810
	20	1803	1803	1802	1801	1801	1800	1799	1799	1798	1798
	30	1791	1791	1790	1789	1788	1788	1787	1787	1786	1786
	40	1779	1778	1778	1777	1776	1776	1775	1774	1774	1773
	50	1767	1766	1765	1765	1764	1763	1763	1762	1762	1761
61	0	1755	1754	1753	1753	1752	1751	1751	1750	1750	1749
	10	1743	1742	1741	1740	1740	1739	1739	1738	1737	1737
	20	1731	1730	1729	1728	1728	1727	1727	1726	1725	1725
	30	1719	1718	1717	1716	1716	1715	1715	1714	1713	1713

TABLE C.
Cor. for Seconds of Parallax.
Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0
S.	**Cor.**
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	2
9	0
S.	**Cor.**
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	1
S.	**Cor.**
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	4
8	2
9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cent. D	M	☽'s Horizontal Parallax. 54′	55′	56′	57′	58′	59′	60′	61′	Table A. Correction for Sec. of Par. Add. S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″
70	0	41.14	40.54	40.33	40.13	39.52	39.32	39.11	38.51	0	20	20	19	19	19	18	18	18	17	17
	10	41.23	41. 3	40.42	40.22	40. 2	39.41	39.21	39. 1	10	17	16	16	16	15	15	15	14	14	14
	20	41.32	41.12	40.51	40.31	40.11	39.51	39.31	39.10	20	13	13	13	12	12	12	11	11	11	10
	30	41.40	41.20	41. 0	40.40	40.20	40. 0	39.40	39.20	30	10	10	9	9	9	8	8	8	7	7
	40	41.49	41.29	41. 9	40.50	40.30	40.10	39.50	39.30	40	7	6	6	6	5	5	5	4	4	4
	50	41.58	41.38	41.18	40.59	40.39	40.19	40. 0	39.40	50	3	3	3	2	2	2	1	1	1	0
71	0	42. 8	41.48	41.28	41. 9	40.49	40.30	40.10	39.51	0	19	19	18	18	18	17	17	17	16	16
	10	42.16	41.57	41.38	41.18	40.59	40.39	40.20	40. 1	10	16	15	15	15	15	14	14	14	13	13
	20	42.25	42. 6	41.47	41.27	41. 8	40.49	40.30	40.11	20	13	12	12	12	11	11	11	10	10	10
	30	42.34	42.15	41.56	41.37	41.18	40.59	40.39	40.20	30	9	9	9	8	8	8	8	7	7	7
	40	42.43	42.24	42. 5	41.46	41.27	41. 8	40.49	40.30	40	6	6	6	5	5	5	4	4	4	3
	50	42.51	42.33	42.14	41.55	41.36	41.18	40.59	40.40	50	3	3	2	2	2	1	1	1	1	0
72	0	43. 1	42.43	42.24	42. 5	41.47	41.28	41.10	40.51	0	18	18	17	17	17	16	16	16	16	15
	10	43.10	42.51	42.33	42.15	41.56	41.38	41.20	41. 1	10	15	15	14	14	14	13	13	13	13	12
	20	43.19	43. 0	42.42	42.24	42. 6	41.48	41.29	41.11	20	12	12	11	11	11	10	10	10	10	9
	30	43.27	43. 9	42.51	42.33	42.15	41.57	41.39	41.21	30	9	9	8	8	8	7	7	7	7	6
	40	43.36	43.18	43. 0	42.43	42.25	42. 7	41.49	41.31	40	6	6	5	5	5	4	4	4	3	3
	50	43.45	43.27	43.10	42.52	42.34	42.17	41.59	41.41	50	3	3	2	2	2	1	1	1	0	0
73	0	43.55	43.37	43.20	43. 2	42.45	42.27	42.10	41.52	0	17	17	16	16	16	16	15	15	15	14
	10	44. 4	43.46	43.29	43.12	42.54	42.37	42.19	42. 2	10	14	14	14	13	13	13	12	12	12	12
	20	44.13	43.55	43.38	43.21	43. 4	42.47	42.29	42.12	20	11	11	11	10	10	10	10	9	9	9
	30	44.21	44. 4	43.47	43.30	43.13	42.56	42.39	42.22	30	8	8	8	8	7	7	7	6	6	6
	40	44.30	44.13	43.57	43.40	43.23	43. 6	42.49	42.32	40	6	5	5	5	4	4	4	4	3	3
	50	44.39	44.22	44. 6	43.49	43.32	43.16	42.59	42.42	50	3	2	2	2	2	1	1	1	0	0
74	0	44.49	44.32	44.16	43.59	43.43	43.26	43.10	42.53	0	16	16	15	15	15	15	14	14	14	14
	10	44.58	44.42	44.25	44. 9	43.52	43.36	43.20	43. 3	10	13	13	13	12	12	12	12	11	11	11
	20	45. 7	44.51	44.34	44.18	44. 2	43.46	43.30	43.13	20	11	10	10	10	10	9	9	9	8	8
	30	45.16	45. 0	44.44	44.28	44.12	43.56	43.40	43.23	30	8	8	7	7	7	7	6	6	6	5
	40	45.25	45. 9	44.53	44.37	44.21	44. 5	43.49	43.34	40	5	5	5	4	4	4	4	3	3	3
	50	45.34	45.18	45. 2	44.46	44.31	44.15	43.59	43.44	50	3	2	2	2	1	1	1	1	0	0
75	0	45.43	45.28	45.12	44.57	44.41	44.26	44.10	43.55	0	15	15	14	14	14	14	13	13	13	13
	10	45.52	45.37	45.22	45. 6	44.51	44.36	44.20	44. 5	10	12	12	12	12	11	11	11	11	10	10
	20	46. 1	45.46	45.31	45.16	45. 1	44.45	44.30	44.15	20	10	10	9	9	9	9	8	8	8	8
	30	46.10	45.55	45.40	45.25	45.10	44.55	44.40	44.25	30	7	7	7	7	6	6	6	6	5	5
	40	46.19	46. 4	45.50	45.35	45.20	45. 5	44.50	44.35	40	5	5	4	4	4	4	3	3	3	3
	50	46.28	46.14	45.59	45.44	45.29	45.15	45. 0	44.45	50	2	2	2	2	1	1	1	1	0	0
76	0	46.38	46.24	46. 9	45.55	45.40	45.26	45.11	44.57	0	14	14	14	13	13	13	13	12	12	12
	10	46.47	46.33	46.18	46. 4	45.50	45.35	45.21	45. 7	10	12	11	11	11	11	10	10	10	10	10
	20	46.56	46.42	46.28	46.14	45.59	45.45	45.31	45.17	20	9	9	9	9	8	8	8	8	7	7
	30	47. 5	46.51	46.37	46.23	46. 9	45.55	45.41	45.27	30	7	7	7	6	6	6	6	5	5	5
	40	47.14	47. 0	46.46	46.33	46.19	46. 5	45.51	45.37	40	5	4	4	4	4	3	3	3	3	3
	50	47.23	47. 9	46.56	46.42	46.28	46.15	46. 1	45.47	50	2	2	2	2	1	1	1	1	0	0
77	0	47.33	47.20	47. 6	46.53	46.39	46.26	46.12	45.59	0	13	13	13	12	12	12	12	11	11	11
	10	47.42	47.29	47.15	47. 2	46.49	46.35	46.22	46. 9	10	11	11	10	10	10	10	10	9	9	9
	20	47.51	47.38	47.25	47.12	46.59	46.45	46.32	46.19	20	9	8	8	8	8	8	7	7	7	7
	30	48. 0	47.47	47.34	47.21	47. 8	46.55	46.42	46.29	30	6	6	6	6	6	5	5	5	5	5
	40	48. 9	47.56	47.44	47.31	47.18	47. 5	46.52	46.39	40	4	4	4	4	3	3	3	3	3	2
	50	48.18	48. 6	47.53	47.40	47.28	47.15	47. 2	46.50	50	2	2	2	1	1	1	1	1	0	0
78	0	48.28	48.16	48. 3	47.51	47.38	47.26	47.13	47. 1	0	12	12	12	11	11	11	11	11	10	10
	10	48.37	48.25	48.13	48. 0	47.48	47.36	47.24	47.11	10	10	10	10	9	9	9	9	9	8	8
	20	48.46	48.34	48.22	48.10	47.58	47.46	47.34	47.21	20	8	8	8	7	7	7	7	7	6	6
	30	48.55	48.44	48.32	48.20	48. 8	47.56	47.44	47.32	30	6	6	6	5	5	5	5	5	4	4
	40	49. 5	48.53	48.41	48.29	48.17	48. 6	47.54	47.42	40	4	4	4	3	3	3	3	3	2	2
	50	49.14	49. 2	48.50	48.39	48.27	48.16	48. 4	47.52	50	2	2	2	1	1	1	1	1	0	0
79	0	49.24	49.12	49. 1	48.49	48.38	48.26	48.15	48. 4	0	11	11	11	10	10	10	10	10	10	9
	10	49.33	49.22	49.10	48.59	48.48	48.36	48.25	48.14	10	9	9	9	9	8	8	8	8	8	8
	20	49.42	49.31	49.20	49. 9	48.57	48.46	48.35	48.24	20	7	7	7	7	7	6	6	6	6	6
	30	49.51	49.40	49.29	49.18	49. 7	48.56	48.45	48.34	30	5	5	5	5	5	5	4	4	4	4
	40	50. 0	49.49	49.39	49.28	49.17	49. 6	48.55	48.45	40	4	3	3	3	3	3	3	2	2	2
	50	50. 9	49.59	49.48	49.37	49.27	49.16	49. 6	48.55	50	2	2	1	1	1	1	1	1	0	0

Tab. B. For M of alt. Add.

M	S
[illegible]	[illegible]

TABLE XIX.

LOGARITHMS.

)'s Hor. Parallax. M	S	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°
		Apparent Altitude of)'s centre.									
54	0	2287	2287	2286	2286	2285	2285	2285	2284	2284	2284
	10	2274	2273	2273	2272	2272	2272	2271	2271	2271	2271
	20	2260	2260	2259	2259	2258	2258	2258	2257	2257	2257
	30	2247	2246	2246	2245	2245	2245	2244	2243	2243	2243
	40	2233	2233	2232	2232	2231	2231	2231	2230	2230	2230
	50	2220	2219	2219	2218	2218	2218	2217	2217	2216	2216
55	0	2206	2206	2205	2205	2204	2204	2204	2203	2203	2203
	10	2193	2192	2192	2191	2191	2191	2190	2190	2190	2190
	20	2179	2179	2179	2178	2178	2178	2177	2176	2176	2176
	30	2166	2166	2165	2165	2164	2164	2164	2163	2163	2163
	40	2153	2152	2152	2152	2151	2151	2150	2150	2150	2150
	50	2140	2139	2139	2138	2138	2138	2137	2137	2137	2137
56	0	2126	2126	2126	2125	2125	2125	2124	2123	2123	2123
	10	2113	2113	2112	2112	2112	2111	2111	2110	2110	2110
	20	2100	2100	2099	2099	2098	2098	2098	2097	2097	2097
	30	2087	2087	2086	2086	2085	2085	2085	2084	2084	2084
	40	2074	2074	2073	2073	2072	2072	2072	2071	2071	2071
	50	2061	2061	2060	2060	2059	2059	2059	2058	2058	2058
57	0	2048	2048	2047	2047	2046	2046	2046	2045	2045	2045
	10	2035	2035	2034	2034	2034	2033	2033	2032	2032	2032
	20	2022	2022	2022	2021	2021	2021	2020	2019	2019	2019
	30	2010	2009	2009	2008	2008	2008	2007	2007	2007	2007
	40	1997	1996	1996	1995	1995	1995	1994	1994	1994	1994
	50	1984	1984	1983	1983	1982	1982	1982	1981	1981	1981
58	0	1971	1971	1970	1970	1970	1970	1969	1968	1968	1968
	10	1959	1958	1958	1957	1957	1957	1956	1956	1956	1956
	20	1946	1946	1945	1945	1944	1944	1944	1943	1943	1943
	30	1933	1933	1933	1932	1932	1932	1931	1931	1930	1930
	40	1921	1920	1920	1920	1919	1919	1919	1918	1918	1918
	50	1908	1908	1907	1907	1907	1907	1906	1905	1905	1905
59	0	1896	1895	1895	1895	1894	1894	1893	1893	1893	1893
	10	1883	1883	1882	1882	1882	1882	1881	1880	1880	1880
	20	1871	1870	1870	1870	1869	1869	1869	1868	1868	1868
	30	1858	1858	1858	1857	1857	1857	1856	1856	1856	1856
	40	1846	1846	1845	1845	1844	1844	1844	1843	1843	1843
	50	1834	1833	1833	1833	1832	1832	1832	1831	1831	1831
60	0	1822	1821	1821	1820	1820	1820	1819	1819	1819	1819
	10	1809	1809	1808	1808	1808	1808	1807	1806	1806	1806
	20	1797	1797	1796	1796	1795	1795	1795	1794	1794	1794
	30	1785	1784	1784	1784	1783	1783	1783	1782	1782	1782
	40	1773	1772	1772	1771	1771	1771	1770	1770	1770	1770
	50	1761	1760	1760	1759	1759	1759	1758	1758	1758	1758
61	0	1749	1748	1748	1747	1747	1747	1746	1746	1746	1746
	10	1736	1736	1736	1735	1735	1735	1734	1734	1734	1734
	20	1724	1724	1724	1723	1723	1723	1722	1722	1722	1722
	30	1712	1712	1712	1711	1711	1711	1710	1710	1710	1710

TABLE C.
Cor. for Seconds of Parallax.
Add.

S.	Cor.	S.	Cor.	S.	Cor.	S.	Cor.
0	12	0	12	0	12	0	12
1	11	1	11	1	11	1	11
2	9	2	9	2	9	2	10
3	8	3	8	3	8	3	8
4	7	4	7	4	7	4	7
5	6	5	5	5	6	5	6
6	4	6	4	6	4	6	5
7	3	7	3	7	3	7	3
8	1	8	2	8	2	8	2
9	0	9	0	9	1	9	1

TABLE XIX.

CORRECTION.

App. alt. ☽'s cent.		☽'s Horizontal Parallax.								Table A. Propor. part for Sec. of Par. Add.											Tab. B For M of alt. Add.	
D	M	54′	55′	56′	57′	58′	59′	60′	61′	S	0″	1″	2″	3″	4″	5″	6″	7″	8″	9″	M	S
80	0	50.19	50. 9	49.58	49.48	49.38	49.27	49.17	49. 6	0	10	10	10	10	9	9	9	9	9	9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
	10	50.28	50.18	50. 8	49.58	49.47	49.37	49.27	49.17	10	8	8	8	8	8	8	7	7	7	7		
	20	50.38	50.27	50.17	50. 7	49.57	49.47	49.37	49.27	20	7	7	6	6	6	6	6	6	5	5		
	30	50.47	50.37	50.27	50.17	50. 7	49.57	49.47	49.37	30	5	5	5	5	4	4	4	4	4	4		
	40	50.56	50.46	50.36	50.27	50.17	50. 7	49.57	49.48	40	3	3	3	3	3	3	2	2	2	2		
	50	51. 5	50.55	50.46	50.36	50.27	50.17	50. 8	49.58	50	2	2	1	1	1	1	1	1	0	0		
81	0	51.15	51. 6	50.56	50.47	50.37	50.28	50.19	50. 9	0	9	9	9	9	8	8	8	8	8	8	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	51.24	51.15	51. 6	50.57	50.47	50.38	50.29	50.20	10	8	7	7	7	7	7	7	6	6	6		
	20	51.33	51.24	51.15	51. 6	50.57	50.48	50.39	50.30	20	6	6	6	6	5	5	5	5	5	5		
	30	51.42	51.34	51.25	51.16	51. 7	50.58	50.49	50.40	30	5	4	4	4	4	4	4	3	3	3		
	40	51.52	51.43	51.34	51.26	51.17	51. 8	50.59	50.51	40	3	3	3	3	2	2	2	2	2	2		
	50	52. 1	51.52	51.44	51.35	51.27	51.18	51.10	51. 1	50	2	1	1	1	1	1	1	0	0	0		
82	0	52.11	52. 3	51.54	51.46	51.38	51.29	51.21	51.13	0	8	8	8	8	7	7	7	7	7	7	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	52.20	52.12	52. 4	51.56	51.47	51.39	51.31	51.23	10	7	7	6	6	6	6	6	6	6	5		
	20	52.29	52.21	52.13	52. 5	51.57	51.49	51.41	51.33	20	5	5	5	5	5	5	5	4	4	4		
	30	52.39	52.31	52.23	52.15	52. 7	51.59	51.52	51.44	30	4	4	4	4	4	3	3	3	3	3		
	40	52.48	52.40	52.32	52.25	52.17	52. 9	52. 2	51.54	40	3	3	2	2	2	2	2	2	2	2		
	50	52.57	52.49	52.42	52.34	52.27	52.19	52.12	52. 4	50	1	1	1	1	1	1	1	0	0	0		
83	0	53. 7	53. 0	52.52	52.45	52.38	52.30	52.23	52.16	0	7	7	7	7	7	6	6	6	6	6	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	53.16	53. 9	53. 2	52.55	52.48	52.41	52.33	52.26	10	6	6	6	6	5	5	5	5	5	5		
	20	53.25	53.18	53.11	53. 5	52.58	52.51	52.44	52.37	20	5	5	4	4	4	4	4	4	4	4		
	30	53.35	53.28	53.21	53.14	53. 7	53. 1	52.54	52.47	30	4	3	3	3	3	3	3	3	3	3		
	40	53.44	53.37	53.31	53.24	53.17	53.11	53. 4	52.57	40	2	2	2	2	2	2	2	2	1	1		
	50	53.53	53.47	53.40	53.34	53.27	53.21	53.14	53. 8	50	1	1	1	1	1	1	1	0	0	0		
84	0	54. 3	53.57	53.51	53.44	53.38	53.32	53.26	53.19	0	6	6	6	6	6	6	5	5	5	5	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	54.12	54. 6	54. 0	53.54	53.48	53.42	53.36	53.30	10	5	5	5	5	5	5	4	4	4	4		
	20	54.22	54.16	54.10	54. 4	53.58	53.52	53.46	53.40	20	4	4	4	4	4	4	3	3	3	3		
	30	54.31	54.25	54.19	54.14	54. 8	54. 2	53.56	53.51	30	3	3	3	3	3	3	2	2	2	2		
	40	54.40	54.35	54.29	54.23	54.18	54.12	54. 7	54. 1	40	2	2	2	2	2	2	2	1	1	1		
	50	54.49	54.44	54.39	54.33	54.28	54.22	54.17	54.11	50	1	1	1	1	1	1	1	0	0	0		
85	0	55. 0	54.54	54.49	54.44	54.39	54.33	54.28	54.23	0	5	5	5	5	5	5	5	4	4	4	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	55. 9	55. 4	54.59	54.54	54.49	54.43	54.38	54.33	10	4	4	4	4	4	4	4	4	4	3		
	20	55.18	55.13	55. 8	55. 3	54.58	54.54	54.49	54.44	20	3	3	3	3	3	3	3	3	3	3		
	30	55.27	55.23	55.18	55.13	55. 8	55. 4	54.59	54.54	30	3	3	2	2	2	2	2	2	2	2		
	40	55.36	55.32	55.27	55.23	55.18	55.14	55. 9	55. 5	40	2	2	2	2	1	1	1	1	1	1		
	50	55.46	55.41	55.37	55.33	55.28	55.24	55.20	55.15	50	1	1	1	1	1	1	1	0	0	0		
86	0	55.56	55.52	55.48	55.43	55.39	55.35	55.31	55.27	0	4	4	4	4	4	4	4	4	4	3	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	56. 5	56. 1	55.57	55.53	55.49	55.45	55.41	55.37	10	3	3	3	3	3	3	3	3	3	3		
	20	56.14	56.11	56. 7	56. 3	55.59	55.55	55.52	55.48	20	3	3	3	3	3	2	2	2	2	2		
	30	56.24	56.20	56.16	56.13	56. 9	56. 5	56. 2	55.58	30	2	2	2	2	2	2	2	2	2	2		
	40	56.33	56.29	56.26	56.22	56.19	56.15	56.12	56. 8	40	2	1	1	1	1	1	1	1	1	1		
	50	56.42	56.39	56.36	56.32	56.29	56.26	56.22	56.19	50	1	1	1	1	1	1	1	0	0	0		
87	0	56.52	56.49	56.46	56.43	56.40	56.37	56.34	56.30	0	3	3	3	3	3	3	3	3	3	3	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	57. 2	56.59	56.56	56.53	56.50	56.47	56.44	56.41	10	3	3	2	2	2	2	2	2	2	2		
	20	57.11	57. 8	57. 5	57. 3	57. 0	56.57	56.54	56.51	20	2	2	2	2	2	2	2	2	2	2		
	30	57.20	57.18	57.15	57.12	57.10	57. 7	57. 4	57. 2	30	2	2	2	2	1	1	1	1	1	1		
	40	57.29	57.27	57.25	57.22	57.20	57.17	57.15	57.12	40	1	1	1	1	1	1	1	1	1	1		
	50	57.39	57.36	57.34	57.32	57.30	57.27	57.25	57.23	50	1	1	1	1	1	1	0	0	0	0		
88	0	57.49	57.47	57.45	57.43	57.41	57.38	57.36	57.34	0	2	2	2	2	2	2	2	2	2	2	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	57.58	57.56	57.54	57.52	57.50	57.49	57.47	57.45	10	2	2	2	2	2	2	2	2	2	1		
	20	58. 7	58. 6	58. 4	58. 2	58. 0	57.59	57.57	57.55	20	1	1	1	1	1	1	1	1	1	1		
	30	58.17	58.15	58.14	58.12	58.10	58. 9	58. 7	58. 6	30	1	1	1	1	1	1	1	1	1	1		
	40	58.26	58.25	58.23	58.22	58.20	58.19	58.18	58.16	40	1	1	1	1	1	1	1	1	1	1		
	50	58.35	58.34	58.33	58.32	58.30	58.29	58.28	58.27	50	1	1	1	1	1	0	0	0	0	0		
89	0	58.45	58.44	58.43	58.42	58.41	58.40	58.39	58.38	0	1	1	1	1	1	1	1	1	1	1	0 1 2 3 4 5 6 7 8 9	[illegible]
	10	58.55	58.54	58.53	58.52	58.51	58.50	58.49	58.49	10	1	1	1	1	1	1	1	1	1	1		
	20	59. 4	59. 3	59. 3	59. 2	59. 1	59. 0	58.59	58.59	20	1	1	1	1	1	1	1	1	1	1		
	30	59.13	59.13	59.12	59.12	59.11	59.11	59.10	59.10	30	1	1	1	1	1	1	1	1	1	1		
	40	59.22	59.22	59.22	59.21	59.21	59.21	59.20	59.20	40	1	1	1	1	1	1	1	1	1	1		
	50	59.32	59.32	59.31	59.31	59.31	59.31	59.31	59.31	50	1	1	1	1	1	0	0	0	0	0		

TABLE XIX.

LOGARITHMS.

☽'s Hor. Parallax.		Apparent Altitude of ☽'s centre.									
M	S	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°
54	0	2283	2283	2283	2283	2283	2283	2283	2283	2283	2283
	10	2270	2270	2270	2270	2269	2269	2269	2269	2269	2269
	20	2256	2256	2256	2256	2256	2256	2256	2256	2256	2256
	30	2243	2243	2242	2242	2242	2242	2242	2242	2242	2242
	40	2229	2229	2229	2229	2229	2229	2229	2229	2229	2229
	50	2216	2216	2216	2215	2215	2215	2215	2215	2215	2215
55	0	2202	2202	2202	2202	2202	2202	2202	2202	2202	2202
	10	2189	2189	2189	2189	2189	2189	2189	2189	2188	2188
	20	2176	2175	2175	2175	2175	2175	2175	2175	2175	2175
	30	2162	2162	2162	2162	2162	2162	2162	2162	2162	2162
	40	2149	2149	2149	2149	2149	2149	2149	2149	2149	2149
	50	2136	2136	2136	2136	2136	2135	2135	2135	2135	2135
56	0	2123	2123	2122	2122	2122	2122	2122	2122	2122	2122
	10	2109	2109	2109	2109	2109	2109	2109	2109	2109	2109
	20	2096	2096	2096	2096	2096	2096	2096	2096	2096	2096
	30	2083	2083	2083	2083	2083	2083	2083	2083	2083	2083
	40	2070	2070	2070	2070	2070	2070	2070	2070	2070	2070
	50	2057	2057	2057	2057	2057	2057	2057	2057	2057	2057
57	0	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044
	10	2032	2031	2031	2031	2031	2031	2031	2031	2031	2031
	20	2019	2019	2019	2018	2018	2018	2018	2018	2018	2018
	30	2006	2006	2006	2006	2006	2006	2006	2005	2005	2005
	40	1993	1993	1993	1993	1993	1993	1993	1993	1993	1993
	50	1980	1980	1980	1980	1980	1980	1980	1980	1980	1980
58	0	1968	1968	1967	1967	1967	1967	1967	1967	1967	1967
	10	1955	1955	1955	1955	1955	1955	1955	1955	1955	1955
	20	1942	1942	1942	1942	1942	1942	1942	1942	1942	1942
	30	1930	1930	1930	1930	1929	1929	1929	1929	1929	1929
	40	1917	1917	1917	1917	1917	1917	1917	1917	1917	1917
	50	1905	1905	1904	1904	1904	1904	1904	1904	1904	1904
59	0	1892	1892	1892	1892	1892	1892	1892	1892	1892	1892
	10	1880	1880	1880	1879	1879	1879	1879	1879	1879	1879
	20	1867	1867	1867	1867	1867	1867	1867	1867	1867	1867
	30	1855	1855	1855	1855	1855	1855	1855	1855	1855	1855
	40	1843	1842	1842	1842	1842	1842	1842	1842	1842	1842
	50	1830	1830	1830	1830	1830	1830	1830	1830	1830	1830
60	0	1818	1818	1818	1818	1818	1818	1818	1818	1818	1818
	10	1806	1806	1806	1806	1805	1805	1805	1805	1805	1805
	20	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793
	30	1781	1781	1781	1781	1781	1781	1781	1781	1781	1781
	40	1769	1769	1769	1769	1769	1769	1769	1769	1769	1769
	50	1757	1757	1757	1757	1757	1757	1757	1757	1757	1757
61	0	1745	1745	1745	1745	1745	1745	1745	1745	1745	1745
	10	1733	1733	1733	1733	1733	1733	1733	1733	1733	1733
	20	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721
	30	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709
M	S	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°

TABLE C.
Correction for Seconds of Parallax.
Add.

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	1
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	5
6	4
7	3
8	2
9	0

S.	Cor.
0	12
1	11
2	9
3	8
4	7
5	6
6	4
7	3
8	2
9	1

S.	Cor.
0	12
1	11
2	10
3	8
4	7
5	6
6	5
7	4
8	2
9	1

TABLE XX.

Corr. Tab. 19		Apparent Distance.											
		10°		11°		12°		13°		14°		15°	
Corr. Tab. 19 + 2 Cr.		Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor
M	M.	″	″	″	″	″	″	″	″	″	″	″	″
0	120	196	178	179	161	166	148	154	136	144	126	135	117
1	119	190	172	174	156	161	143	149	131	140	122	131	113
2	118	184	166	169	151	156	138	145	127	136	118	127	109
3	117	178	160	164	146	151	133	141	123	132	114	124	106
4	116	173	155	159	141	147	129	136	118	128	110	120	102
5	115	167	149	154	136	142	124	132	114	124	106	116	98
6	114	162	144	149	131	138	120	128	110	120	102	113	95
7	113	157	139	144	126	133	115	124	106	116	98	109	91
8	112	152	134	139	121	129	111	120	102	113	95	106	88
9	111	146	128	135	117	125	107	116	98	109	91	103	85
10	110	142	124	130	112	121	103	112	94	105	87	99	81
11	109	137	119	126	108	116	98	109	91	102	84	96	78
12	108	132	114	121	103	112	94	105	87	99	81	93	75
13	107	127	109	117	99	109	91	101	83	95	77	90	72
14	106	123	105	113	95	105	87	98	80	92	74	87	69
15	105	118	100	109	91	101	83	94	76	89	71	84	66
16	104	114	96	105	87	97	79	91	73	86	68	81	63
17	103	109	91	101	83	94	76	88	70	83	65	78	60
18	102	105	87	97	79	90	72	85	67	80	62	75	57
19	101	101	83	93	75	87	69	81	63	77	59	73	55
20	100	97	79	90	72	84	66	78	60	74	56	70	52
21	99	93	75	86	68	80	62	75	57	71	53	68	50
22	98	89	71	83	65	77	59	73	55	69	51	65	47
23	97	86	68	79	61	74	56	70	52	66	48	63	45
24	96	82	64	76	58	71	53	67	49	63	45	60	42
25	95	79	61	73	55	68	50	64	46	61	43	58	40
26	94	75	57	70	52	65	47	62	44	58	40	56	38
27	93	72	54	67	49	63	45	59	41	56	38	53	35
28	92	69	51	64	46	60	42	57	39	54	36	51	33
29	91	66	48	61	43	57	39	54	36	52	34	49	31
30	90	63	45	58	40	55	37	52	34	49	31	47	29
31	89	60	42	56	38	53	35	50	32	47	29	45	27
32	88	57	39	53	35	50	32	48	30	45	27	44	26
33	87	54	36	51	33	48	30	46	28	44	26	42	24
34	86	51	33	48	30	46	28	44	26	42	24	40	22
35	85	49	31	46	28	44	26	42	24	40	22	38	20
36	84	46	28	44	26	42	24	40	22	38	20	37	19
37	83	44	26	42	24	40	22	38	20	37	19	35	17
38	82	42	24	40	22	38	20	36	18	35	17	34	16
39	81	40	22	38	20	36	18	35	17	33	15	32	14
40	80	38	20	36	18	34	16	33	15	32	14	31	13
41	79	36	18	34	16	33	15	32	14	31	13	30	12
42	78	34	16	33	15	31	13	30	12	29	11	29	11
43	77	32	14	31	13	30	12	29	11	28	10	27	9
44	76	31	13	29	11	29	11	28	10	27	9	26	8
45	75	29	11	28	10	27	9	27	9	26	8	25	7
46	74	28	10	27	9	26	8	25	7	25	7	24	6
47	73	26	8	26	8	25	7	24	6	24	6	24	6
48	72	25	7	24	6	24	6	23	5	23	5	23	5
49	71	24	6	23	5	23	5	23	5	22	4	22	4
50	70	23	5	22	4	22	4	22	4	21	3	21	3
52	68	21	3	21	3	21	3	20	2	20	2	20	2
55	65	19	1	19	1	19	1	19	1	19	1	19	1
60	60	18	0	18	0	18	0	18	0	18	0	18	0
		Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor
		10°		11°		12°		13°		14°		15°	

Corr. Tab. 19.	Corr. Tab. 19. + 2 Cr.	Apparent Distance. 16° Tab.19.	16° Tab.19. +2Cor	17° Tab.19.	17° Tab.19. +2Cor	18° Tab.19.	18° Tab.19. +2Cor	19° Tab.19.	19° Tab.19. +2Cor	20° Tab.19.	20° Tab.19. +2Cor	21° Tab.19.	21° Tab.19. +2Cor	22° Tab.19.	22° Tab.19. +2Cor
M	M.	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	120	127	109	121	103	115	97	109	91	104	86	100	82	96	78
1	119	124	106	117	99	111	93	106	88	101	83	97	79	93	75
2	118	120	102	114	96	108	90	103	85	99	81	94	76	91	73
3	117	117	99	111	93	105	87	100	82	96	78	92	74	88	70
4	116	113	95	107	89	102	84	97	79	93	75	89	71	86	68
5	115	110	92	104	86	99	81	95	77	90	72	87	69	83	65
6	114	107	89	101	83	96	78	92	74	88	70	84	66	81	63
7	113	103	85	98	80	93	75	89	71	85	67	82	64	79	61
8	112	100	82	95	77	91	73	86	68	83	65	79	61	76	58
9	111	97	79	92	74	88	70	84	66	80	62	77	59	74	56
10	110	94	76	89	71	85	67	81	63	78	60	75	57	72	54
11	109	91	73	86	68	82	64	79	61	76	58	73	55	70	52
12	108	88	70	84	66	80	62	76	58	73	55	70	52	68	50
13	107	85	67	81	63	77	59	74	56	71	53	68	50	66	48
14	106	82	64	78	60	75	57	72	54	69	51	66	48	64	46
15	105	80	62	76	58	72	54	69	51	67	49	64	46	62	44
16	104	77	59	73	55	70	52	67	49	64	46	62	44	60	42
17	103	74	56	71	53	68	50	65	47	62	44	60	42	58	40
18	102	72	54	68	50	65	47	63	45	60	42	58	40	56	38
19	101	69	51	66	48	63	45	61	43	58	40	56	38	54	36
20	100	67	49	64	46	61	43	59	41	56	38	54	36	53	35
21	99	64	46	61	43	59	41	57	39	54	36	53	35	51	33
22	98	62	44	59	41	57	39	55	37	53	35	51	33	49	31
23	97	60	42	57	39	55	37	53	35	51	33	49	31	48	30
24	96	57	39	55	37	53	35	51	33	49	31	47	29	46	28
25	95	55	37	53	35	51	33	49	31	47	29	46	28	44	26
26	94	53	35	51	33	49	31	47	29	46	28	44	26	43	25
27	93	51	33	49	31	47	29	46	28	44	26	43	25	42	24
28	92	49	31	47	29	45	27	44	26	43	25	41	23	40	22
29	91	47	29	45	27	44	26	42	24	41	23	40	22	39	21
30	90	45	27	44	26	42	24	41	23	40	22	38	20	37	19
31	89	44	26	42	24	41	23	39	21	38	20	37	19	36	18
32	88	42	24	40	22	39	21	38	20	37	19	36	18	35	17
33	87	40	22	39	21	38	20	36	18	35	17	35	17	34	16
34	86	39	21	37	19	36	18	35	17	34	16	33	15	33	15
35	85	37	19	36	18	35	17	34	16	33	15	32	14	31	13
36	84	36	18	34	16	33	15	33	15	32	14	31	13	30	12
37	83	34	16	33	15	32	14	31	13	31	13	30	12	29	11
38	82	33	15	32	14	31	13	30	12	30	12	29	11	28	10
39	81	31	13	31	13	30	12	29	11	29	11	28	10	28	10
40	80	30	12	29	11	29	11	28	10	28	10	27	9	27	9
41	79	29	11	28	10	28	10	27	9	27	9	26	8	26	8
42	78	28	10	27	9	27	9	26	8	26	8	25	7	25	7
43	77	27	9	26	8	26	8	25	7	25	7	25	7	24	6
44	76	26	8	25	7	25	7	24	6	24	6	24	6	24	6
45	75	25	7	24	6	24	6	24	6	23	5	23	5	23	5
46	74	24	6	24	6	23	5	23	5	23	5	22	4	22	4
47	73	23	5	23	5	23	5	22	4	22	4	22	4	22	4
48	72	22	4	22	4	22	4	22	4	21	3	21	3	21	3
49	71	22	4	21	3	21	3	21	3	21	3	21	3	21	3
50	70	21	3	21	3	21	3	21	3	20	2	20	2	20	2
52	68	20	2	20	2	20	2	20	2	20	2	19	1	19	1
55	65	19	1	19	1	19	1	19	1	19	1	19	1	19	1
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab.19. 16°	Tab.19. +2Cor	Tab.19. 17°	Tab.19. +2Cor	Tab.19. 18°	Tab.19. +2Cor	Tab.19. 19°	Tab.19. +2Cor	Tab.19. 20°	Tab.19. +2Cor	Tab.19. 21°	Tab.19. +2Cor	Tab.19. 22°	Tab.19. +C2or

TABLE XX.

Corr. Tab. 19.	Corr. Tab. 19. + 2 Cr.	Apparent Distance. 23° Tab.19.	23° Tab.19. +2Cor	24° Tab.19.	24° Tab.19. +2Cor	25° Tab.19.	25° Tab.19. +2Cor	26° Tab.19.	26° Tab.19. +2Cor	27° Tab.19.	27° Tab.19. +2Cor	28° Tab.19.	28° Tab.19. +2Cor	29° Tab.19.	29° Tab.19. +2Cor	30° Tab.19.	30° Tab.19. +2Cor
M	M.	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
0	120	92	74	89	71	85	67	82	64	80	62	77	59	75	57	72	54
1	119	90	72	86	68	83	65	80	62	78	60	75	57	73	55	71	53
2	118	87	69	84	66	81	63	78	60	76	58	73	55	71	53	69	51
3	117	85	67	82	64	79	61	76	58	74	56	71	53	69	51	67	49
4	116	82	64	79	61	77	59	74	56	72	54	69	51	67	49	65	47
5	115	80	62	77	59	75	57	72	54	70	52	68	50	66	48	64	46
6	114	78	60	75	57	73	55	70	52	68	50	66	48	64	46	62	44
7	113	76	58	73	55	71	53	68	50	66	48	64	46	62	44	60	42
8	112	74	56	71	53	69	51	66	48	64	46	62	44	61	43	59	41
9	111	71	53	69	51	67	49	65	47	63	45	61	43	59	41	57	39
10	110	69	51	67	49	65	47	63	45	61	43	59	41	57	39	56	38
11	109	67	49	65	47	63	45	61	43	59	41	57	39	56	38	54	36
12	108	65	47	63	45	61	43	59	41	57	39	56	38	54	36	53	35
13	107	63	45	61	43	59	41	58	40	56	38	54	36	53	35	51	33
14	106	61	43	59	41	58	40	56	38	54	36	53	35	51	33	50	32
15	105	60	42	58	40	56	38	54	36	53	35	51	33	50	32	49	31
16	104	58	40	56	38	54	36	53	35	51	33	50	32	48	30	47	29
17	103	56	38	54	36	53	35	51	33	50	32	48	30	47	29	46	28
18	102	54	36	53	35	51	33	50	32	48	30	47	29	46	28	45	27
19	101	53	35	51	33	49	31	48	30	47	29	46	28	44	26	43	25
20	100	51	33	49	31	48	30	47	29	45	27	44	26	43	25	42	24
21	99	49	31	48	30	46	28	45	27	44	26	43	25	42	24	41	23
22	98	48	30	46	28	45	27	44	26	43	25	42	24	41	23	40	22
23	97	46	28	45	27	44	26	42	24	41	23	40	22	40	22	39	21
24	96	45	27	43	25	42	24	41	23	40	22	39	21	38	20	38	20
25	95	43	25	42	24	41	23	40	22	39	21	38	20	37	19	37	19
26	94	42	24	41	23	40	22	39	21	38	20	37	19	36	18	35	17
27	93	40	22	39	21	38	20	37	19	37	19	36	18	35	17	34	16
28	92	39	21	38	20	37	19	36	18	36	18	35	17	34	16	33	15
29	91	38	20	37	19	36	18	35	17	34	16	34	16	33	15	33	15
30	90	37	19	36	18	35	17	34	16	33	15	33	15	32	14	32	14
31	89	35	17	34	16	34	16	33	15	32	14	32	14	31	13	31	13
32	88	34	16	33	15	33	15	32	14	31	13	31	13	30	12	30	12
33	87	33	15	32	14	32	14	31	13	30	12	30	12	29	11	29	11
34	86	32	14	31	13	31	13	30	12	30	12	29	11	29	11	28	10
35	85	31	13	30	12	30	12	29	11	29	11	28	10	28	10	27	9
36	84	30	12	29	11	29	11	28	10	28	10	27	9	27	9	27	9
37	83	29	11	28	10	28	10	27	9	27	9	27	9	26	8	26	8
38	82	28	10	27	9	27	9	27	9	26	8	26	8	26	8	25	7
39	81	27	9	27	9	26	8	26	8	26	8	25	7	25	7	25	7
40	80	26	8	26	8	25	7	25	7	25	7	25	7	24	6	24	6
41	79	25	7	25	7	25	7	24	6	24	6	24	6	24	6	23	5
42	78	25	7	24	6	24	6	24	6	24	6	23	5	23	5	23	5
43	77	24	6	24	6	23	5	23	5	23	5	23	5	23	5	22	4
44	76	23	5	23	5	23	5	23	5	22	4	22	4	22	4	22	4
45	75	23	5	22	4	22	4	22	4	22	4	22	4	22	4	21	3
46	74	22	4	22	4	22	4	22	4	21	3	21	3	21	3	21	3
47	73	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3
48	72	21	3	21	3	21	3	21	3	20	2	20	2	20	2	20	2
49	71	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
50	70	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
52	68	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
55	65	19	1	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab.19. 23°	Tab.19. +2Cor	Tab.19. 24°	Tab.19. +2Cor	Tab.19. 25°	Tab.19. +2Cor	Tab.19. 26°	Tab.19. +2Cor	Tab.19. 27°	Tab.19. +2Cor	Tab.19. 28°	Tab.19. +2Cor	Tab.19. 29°	Tab.19. +2Cor	Tab.19. 30°	Tab.19. +2Cor

Corr. Tab. 19.	Corr. Tab. 19. + 2 Cr.	Apparent Distance. 31° Tab.19.	31° Tab.19. +2Cor	32° Tab.19.	32° Tab.19. +2Cor	33° Tab.19.	33° Tab.19. +2Cor	34° Tab.19.	34° Tab.19. +2Cor	35° Tab.19.	35° Tab.19. +2Cor	36° Tab.19.	36° Tab.19. +2Cor	37° Tab.19.	37° Tab.19. +2Cor	38° Tab.19.	38° Tab.19. +2Cor
M	M.	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	120	70	52	68	50	66	48	65	47	63	45	61	43	60	42	58	40
1	119	69	51	67	49	65	47	63	45	61	43	60	42	58	40	57	39
2	118	67	49	65	47	63	45	62	44	60	42	58	40	57	39	56	38
3	117	65	47	63	45	62	44	60	42	58	40	57	39	56	38	54	36
4	116	64	46	62	44	60	42	59	41	57	39	56	38	54	36	53	35
5	115	62	44	60	42	59	41	57	39	56	38	54	36	53	35	52	34
6	114	60	42	59	41	57	39	56	38	54	36	53	35	52	34	51	33
7	113	59	41	57	39	56	38	54	36	53	35	52	34	51	33	49	31
8	112	57	39	56	38	54	36	53	35	52	34	50	32	49	31	48	30
9	111	56	38	54	36	53	35	52	34	50	32	49	31	48	30	47	29
10	110	54	36	53	35	52	34	50	32	49	31	48	30	47	29	46	28
11	109	53	35	52	34	50	32	49	31	48	30	47	29	46	28	45	27
12	108	51	33	50	32	49	31	48	30	47	29	46	28	45	27	44	26
13	107	50	32	49	31	48	30	47	29	46	28	45	27	44	26	43	25
14	106	49	31	48	30	46	28	45	27	44	26	43	25	43	25	42	24
15	105	47	29	46	28	45	27	44	26	43	25	42	24	41	23	41	23
16	104	46	28	45	27	44	26	43	25	42	24	41	23	40	22	40	22
17	103	45	27	44	26	43	25	42	24	41	23	40	22	39	21	39	21
18	102	44	26	43	25	42	24	41	23	40	22	39	21	38	20	38	20
19	101	42	24	41	23	41	23	40	22	39	21	38	20	37	19	37	19
20	100	41	23	40	22	39	21	39	21	38	20	37	19	37	19	36	18
21	99	40	22	39	21	38	20	38	20	37	19	36	18	36	18	35	17
22	98	39	21	38	20	37	19	37	19	36	18	35	17	35	17	34	16
23	97	38	20	37	19	36	18	36	18	35	17	34	16	34	16	33	15
24	96	37	19	36	18	35	17	35	17	34	16	34	16	33	15	32	14
25	95	36	18	35	17	34	16	34	16	33	15	33	15	32	14	32	14
26	94	35	17	34	16	34	16	33	15	32	14	32	14	31	13	31	13
27	93	34	16	33	15	33	15	32	14	32	14	31	13	31	13	30	12
28	92	33	15	32	14	32	14	31	13	31	13	30	12	30	12	29	11
29	91	32	14	31	13	31	13	30	12	30	12	30	12	29	11	29	11
30	90	31	13	31	13	30	12	30	12	29	11	29	11	28	10	28	10
31	89	30	12	30	12	29	11	29	11	28	10	28	10	28	10	27	9
32	88	29	11	29	11	29	11	28	10	28	10	27	9	27	9	27	9
33	87	29	11	28	10	28	10	27	9	27	9	27	9	26	8	26	8
34	86	28	10	27	9	27	9	27	9	26	8	26	8	26	8	26	8
35	85	27	9	27	9	26	8	26	8	26	8	26	8	25	7	25	7
36	84	26	8	26	8	26	8	25	7	25	7	25	7	25	7	24	6
37	83	26	8	25	7	25	7	25	7	25	7	24	6	24	6	24	6
38	82	25	7	25	7	25	7	24	6	24	6	24	6	24	6	23	5
39	81	24	6	24	6	24	6	24	6	23	5	23	5	23	5	23	5
40	80	24	6	24	6	23	5	23	5	23	5	23	5	23	5	22	4
41	79	23	5	23	5	23	5	23	5	22	4	22	4	22	4	22	4
42	78	23	5	23	5	22	4	22	4	22	4	22	4	22	4	22	4
43	77	22	4	22	4	22	4	22	4	22	4	21	3	21	3	21	3
44	76	22	4	22	4	21	3	21	3	21	3	21	3	21	3	21	3
45	75	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3
46	74	21	3	21	3	21	3	21	3	20	2	20	2	20	2	20	2
47	73	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
48	72	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
49	71	20	2	20	2	20	2	20	2	20	2	19	1	19	1	19	1
50	70	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
52	68	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
55	65	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab.19. 31°	Tab.19. +2Cor	Tab.19. 32°	Tab.19. +2Cor	Tab.19. 33°	Tab.19. +2Cor	Tab.19. 34°	Tab.19. +2Cor	Tab.19. 35°	Tab.19. +2Cor	Tab.19. 36°	Tab.19. +2Cor	Tab.19. 37°	Tab.19. +2Cor	Tab.19. 38°	Tab.19. +2Cor

Corr. Tab. 19.	Corr. Tab. 19. + 2 Cr.	Apparent Distance. 39° Tab.19.	39° Tab.19. +2Cor	40° Tab.19.	40° Tab.19. +2Cor	41° Tab.19.	41° Tab.19. +2Cor	42° Tab.19.	42° Tab.19. +2Cor	43° Tab.19.	43° Tab.19. +2Cor	44° Tab.19.	44° Tab.19. +2Cor	45° Tab.19.	45° Tab.19. +2Cor	46° Tab.19.	46° Tab.19. +2Cor
M	M.	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	120	57	39	55	37	54	36	53	35	52	34	51	33	49	31	48	30
1	119	56	38	54	36	53	35	52	34	51	33	49	31	48	30	47	29
2	118	54	36	53	35	52	34	51	33	49	31	48	30	47	29	46	28
3	117	53	35	52	34	51	33	49	31	48	30	47	29	46	28	45	27
4	116	52	34	51	33	49	31	48	30	47	29	46	28	45	27	44	26
5	115	51	33	49	31	48	30	47	29	46	28	45	27	44	26	43	25
6	114	49	31	48	30	47	29	46	28	45	27	44	26	43	25	43	25
7	113	48	30	47	29	46	28	45	27	44	26	43	25	43	25	42	24
8	112	47	29	46	28	45	27	44	26	43	25	42	24	42	24	41	23
9	111	46	28	45	27	44	26	43	25	42	24	42	24	41	23	40	22
10	110	45	27	44	26	43	25	42	24	41	23	41	23	40	22	39	21
11	109	44	26	43	25	42	24	41	23	40	22	40	22	39	21	38	20
12	108	43	25	42	24	41	23	40	22	40	22	39	21	38	20	37	19
13	107	42	24	41	23	40	22	39	21	39	21	38	20	37	19	37	19
14	106	41	23	40	22	39	21	39	21	38	20	37	19	36	18	36	18
15	105	40	22	39	21	38	20	38	20	37	19	36	18	36	18	35	17
16	104	39	21	38	20	37	19	37	19	36	18	35	17	35	17	34	16
17	103	38	20	37	19	37	19	36	18	35	17	35	17	34	16	34	16
18	102	37	19	36	18	36	18	35	17	35	17	34	16	33	15	33	15
19	101	36	18	35	17	35	17	34	16	34	16	33	15	33	15	32	14
20	100	35	17	35	17	34	16	34	16	33	15	32	14	32	14	31	13
21	99	34	16	34	16	33	15	33	15	32	14	32	14	31	13	31	13
22	98	34	16	33	15	32	14	32	14	32	14	31	13	31	13	30	12
23	97	33	15	32	14	32	14	31	13	31	13	30	12	30	12	30	12
24	96	32	14	31	13	31	13	31	13	30	12	30	12	29	11	29	11
25	95	31	13	31	13	30	12	30	12	29	11	29	11	29	11	28	10
26	94	30	12	30	12	30	12	29	11	29	11	28	10	28	10	28	10
27	93	30	12	29	11	29	11	29	11	28	10	28	10	28	10	27	9
28	92	29	11	29	11	28	10	28	10	28	10	27	9	27	9	27	9
29	91	28	10	28	10	28	10	27	9	27	9	27	9	26	8	26	8
30	90	28	10	27	9	27	9	27	9	26	8	26	8	26	8	26	8
31	89	27	9	27	9	26	8	26	8	26	8	26	8	25	7	25	7
32	88	26	8	26	8	26	8	26	8	25	7	25	7	25	7	25	7
33	87	26	8	26	8	25	7	25	7	25	7	25	7	24	6	24	6
34	86	25	7	25	7	25	7	25	7	24	6	24	6	24	6	24	6
35	85	25	7	24	6	24	6	24	6	24	6	24	6	23	5	23	5
36	84	24	6	24	6	24	6	24	6	23	5	23	5	23	5	23	5
37	83	24	6	24	6	23	5	23	5	23	5	23	5	23	5	22	4
38	82	23	5	23	5	23	5	23	5	23	5	22	4	22	4	22	4
39	81	23	5	23	5	22	4	22	4	22	4	22	4	22	4	22	4
40	80	22	4	22	4	22	4	22	4	22	4	22	4	21	3	21	3
41	79	22	4	22	4	22	4	21	3	21	3	21	3	21	3	21	3
42	78	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3
43	77	21	3	21	3	21	3	21	3	21	3	21	3	21	3	20	2
44	76	21	3	21	3	21	3	20	2	20	2	20	2	20	2	20	2
45	75	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
46	74	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
47	73	20	2	20	2	20	2	20	2	20	2	20	2	19	1	19	1
48	72	20	2	19	1	19	1	19	1	19	1	19	1	19	1	19	1
49	71	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
50	70	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
52	68	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
55	65	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor
		39°		40°		41°		42°		43°		44°		45°		46°	

Apparent Distance.

Corr. Tab. 19. M	Corr. Tab. 19. +2 Cr. M.	47° Tab. 19. ″	47° Tab. 19. +2Cor ″	48° Tab. 19. ″	48° Tab. 19. +2Cor ″	49° Tab. 19. ″	49° Tab. 19. +2Cor ″	50° Tab. 19. ″	50° Tab. 19. +2Cor ″	51° Tab. 19. ″	51° Tab. 19. +2Cor ″	52° Tab. 19. ″	52° Tab. 19. +2Cor ″	53° Tab. 19. ″	53° Tab. 19. +2Cor ″	54° Tab. 19. ″	54° Tab. 19. +2Cor ″
0	120	47	29	46	28	45	27	44	26	43	25	43	25	42	24	41	23
1	119	46	28	45	27	44	26	43	25	43	25	42	24	41	23	40	22
2	118	45	27	44	26	44	26	43	25	42	24	41	23	40	22	39	21
3	117	44	26	44	26	43	25	42	24	41	23	40	22	39	21	39	21
4	116	44	26	43	25	42	24	41	23	40	22	39	21	39	21	38	20
5	115	43	25	42	24	41	23	40	22	39	21	39	21	38	20	37	19
6	114	42	24	41	23	40	22	39	21	39	21	38	20	37	19	36	18
7	113	41	23	40	22	39	21	39	21	38	20	37	19	36	18	36	18
8	112	40	22	39	21	39	21	38	20	37	19	36	18	36	18	35	17
9	111	39	21	38	20	38	20	37	19	36	18	36	18	35	17	34	16
10	110	38	20	38	20	37	19	36	18	36	18	35	17	34	16	34	16
11	109	38	20	37	19	36	18	36	18	35	17	34	16	34	16	33	15
12	108	37	19	36	18	35	17	35	17	34	16	34	16	33	15	33	15
13	107	36	18	35	17	35	17	34	16	34	16	33	15	33	15	32	14
14	106	35	17	35	17	34	16	33	15	33	15	32	14	32	14	31	13
15	105	34	16	34	16	33	15	33	15	32	14	32	14	31	13	31	13
16	104	34	16	33	15	33	15	32	14	32	14	31	13	31	13	30	12
17	103	33	15	33	15	32	14	32	14	31	13	31	13	30	12	30	12
18	102	32	14	32	14	31	13	31	13	30	12	30	12	30	12	29	11
19	101	32	14	31	13	31	13	30	12	30	12	29	11	29	11	29	11
20	100	31	13	31	13	30	12	30	12	29	11	29	11	29	11	28	10
21	99	30	12	30	12	30	12	29	11	29	11	28	10	28	10	28	10
22	98	30	12	29	11	29	11	29	11	28	10	28	10	27	9	27	9
23	97	29	11	29	11	28	10	28	10	28	10	27	9	27	9	27	9
24	96	29	11	28	10	28	10	27	9	27	9	27	9	27	9	26	8
25	95	28	10	28	10	27	9	27	9	27	9	26	8	26	8	26	8
26	94	27	9	27	9	27	9	26	8	26	8	26	8	26	8	25	7
27	93	27	9	27	9	26	8	26	8	26	8	25	7	25	7	25	7
28	92	26	8	26	8	26	8	25	7	25	7	25	7	25	7	24	6
29	91	26	8	26	8	25	7	25	7	25	7	25	7	24	6	24	6
30	90	25	7	25	7	25	7	25	7	24	6	24	6	24	6	24	6
31	89	25	7	25	7	24	6	24	6	24	6	24	6	24	6	23	5
32	88	24	6	24	6	24	6	24	6	24	6	23	5	23	5	23	5
33	87	24	6	24	6	24	6	23	5	23	5	23	5	23	5	23	5
34	86	24	6	23	5	23	5	23	5	23	5	23	5	22	4	22	4
35	85	23	5	23	5	23	5	23	5	22	4	22	4	22	4	22	4
36	84	23	5	23	5	22	4	22	4	22	4	22	4	22	4	22	4
37	83	22	4	22	4	22	4	22	4	22	4	22	4	21	3	21	3
38	82	22	4	22	4	22	4	22	4	21	3	21	3	21	3	21	3
39	81	22	4	21	3	21	3	21	3	21	3	21	3	21	3	21	3
40	80	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3
41	79	21	3	21	3	21	3	21	3	21	3	20	2	20	2	20	2
42	78	21	3	21	3	20	2	20	2	20	2	20	2	20	2	20	2
43	77	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
44	76	20	2	20	2	20	2	20	2	20	2	20	2	20	2	20	2
45	75	20	2	20	2	20	2	20	2	20	2	20	2	19	1	19	1
46	74	20	2	20	2	19	1	19	1	19	1	19	1	19	1	19	1
47	73	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
48	72	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
49	71	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
50	70	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
52	68	19	1	19	1	18	0	18	0	18	0	18	0	18	0	18	0
55	65	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor	Tab. 19.	Tab. 19. +2Cor
		47°		48°		49°		50°		51°		52°		53°		54°	

TABLE XX.

Corr. Tab.19.		Apparent Distance. 55°		56°		57°		58°		59°		60°		65°		70°	
Corr. Tab.19. +2 Cr.		Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor
M	M.	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
0	120	40	22	39	21	38	20	38	20	37	19	36	18	33	15	29	11
1	119	39	21	38	20	38	20	37	19	36	18	36	18	32	14	29	11
2	118	39	21	38	20	37	19	36	18	36	18	35	17	32	14	29	11
3	117	38	20	37	19	36	18	36	18	35	17	34	16	31	13	28	10
4	116	37	19	36	18	36	18	35	17	34	16	34	16	31	13	28	10
5	115	36	18	36	18	35	17	34	16	34	16	33	15	30	12	28	10
6	114	36	18	35	17	35	17	34	16	33	15	33	15	30	12	27	9
7	113	35	17	35	17	34	16	33	15	33	15	32	14	29	11	27	9
8	112	35	17	34	16	33	15	33	15	32	14	32	14	29	11	27	9
9	111	34	16	33	15	33	15	32	14	32	14	31	13	29	11	26	8
10	110	33	15	33	15	32	14	32	14	31	13	31	13	28	10	26	8
11	109	33	15	32	14	32	14	31	13	31	13	30	12	28	10	26	8
12	108	32	14	32	14	31	13	31	13	30	12	30	12	27	9	25	7
13	107	31	13	31	13	31	13	30	12	30	12	29	11	27	9	25	7
14	106	31	13	30	12	30	12	30	12	29	11	29	11	27	9	25	7
15	105	30	12	30	12	29	11	29	11	29	11	28	10	26	8	24	6
16	104	30	12	29	11	29	11	29	11	28	10	28	10	26	8	24	6
17	103	29	11	29	11	28	10	28	10	28	10	27	9	26	8	24	6
18	102	29	11	28	10	28	10	28	10	27	9	27	9	25	7	24	6
19	101	28	10	28	10	28	10	27	9	27	9	26	8	25	7	23	5
20	100	28	10	27	9	27	9	27	9	26	8	26	8	25	7	23	5
21	99	27	9	27	9	27	9	26	8	26	8	26	8	24	6	23	5
22	98	27	9	26	8	26	8	26	8	26	8	25	7	24	6	23	5
23	97	26	8	26	8	26	8	25	7	25	7	25	7	24	6	22	4
24	96	26	8	26	8	25	7	25	7	25	7	25	7	23	5	22	4
25	95	25	7	25	7	25	7	25	7	24	6	24	6	23	5	22	4
26	94	25	7	25	7	25	7	24	6	24	6	24	6	23	5	22	4
27	93	25	7	24	6	24	6	24	6	24	6	23	5	22	4	21	3
28	92	24	6	24	6	24	6	24	6	23	5	23	5	22	4	21	3
29	91	24	6	24	6	23	5	23	5	23	5	23	5	22	4	21	3
30	90	23	5	23	5	23	5	23	5	23	5	23	5	22	4	21	3
31	89	23	5	23	5	23	5	23	5	22	4	22	4	21	3	21	3
32	88	23	5	23	5	22	4	22	4	22	4	22	4	21	3	20	2
33	87	22	4	22	4	22	4	22	4	22	4	22	4	21	3	20	2
34	86	22	4	22	4	22	4	22	4	22	4	21	3	21	3	20	2
35	85	22	4	22	4	22	4	21	3	21	3	21	3	21	3	20	2
36	84	22	4	21	3	21	3	21	3	21	3	21	3	20	2	20	2
37	83	21	3	21	3	21	3	21	3	21	3	21	3	20	2	20	2
38	82	21	3	21	3	21	3	21	3	21	3	20	2	20	2	20	2
39	81	21	3	21	3	20	2	20	2	20	2	20	2	20	2	19	1
40	80	20	2	20	2	20	2	20	2	20	2	20	2	20	2	19	1
41	79	20	2	20	2	20	2	20	2	20	2	20	2	19	1	19	1
42	78	20	2	20	2	20	2	20	2	20	2	20	2	19	1	19	1
43	77	20	2	20	2	20	2	20	2	20	2	19	1	19	1	19	1
44	76	20	2	20	2	19	1	19	1	19	1	19	1	19	1	19	1
45	75	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
46	74	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
47	73	19	1	19	1	19	1	19	1	19	1	19	1	19	1	19	1
48	72	19	1	19	1	19	1	19	1	19	1	19	1	19	1	18	0
49	71	19	1	19	1	19	1	19	1	19	1	19	1	18	0	18	0
50	70	19	1	19	1	19	1	19	1	19	1	19	1	18	0	18	0
52	68	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
55	65	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
60	60	18	0	18	0	18	0	18	0	18	0	18	0	18	0	18	0
		Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor	Tab.19.	Tab.19. +2Cor
		55°		56°		57°		58°		59°		60°		65°		70°	

Corr. Tab19	Cor. Tab19 +2 Cr	75° Tab.19.	75° Tab.19. +2Cor	80° Tab.19.	80° Tab.19. +2Cor	85° Tab.19.	85° Tab.19. +2Cor	90° Tab.19.	90° Tab.19. +2Cor	95° Tab.19.	95° Tab.19. +2Cor	100° Tab.19.	100° Tab.19. +2Cor	105° Tab.19.	105° Tab.19. +2Cor	110° Tab.19.	110° Tab.19. +2Cor	115° Tab.19.	115° Tab.19. +2Cor	120° Tab.19.	120° Tab.19. +2Cor
M	M.	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
0	120	26	8	24	6	21	3	18	0	3	21	6	24	8	26	11	29	15	33	13	36
1	119	26	8	23	5	21	3	18	0	3	21	5	23	8	26	11	29	14	32	18	36
2	118	26	8	23	5	21	3	18	0	3	21	5	23	8	26	11	29	14	32	17	35
3	117	26	8	23	5	20	2	18	0	2	20	5	23	8	26	10	28	13	31	16	34
4	116	25	7	23	5	20	2	18	0	2	20	5	23	7	25	10	28	13	31	16	34
5	115	25	7	23	5	20	2	18	0	2	20	5	23	7	25	10	28	12	30	15	33
6	114	25	7	22	4	20	2	18	0	2	20	4	22	7	25	9	27	12	30	15	33
7	113	25	7	22	4	20	2	18	0	2	20	4	22	7	25	9	27	11	29	14	32
8	112	24	6	22	4	20	2	18	0	2	20	4	22	6	24	9	27	11	29	14	32
9	111	24	6	22	4	20	2	18	0	2	20	4	22	6	24	8	26	11	29	13	31
10	110	24	6	22	4	20	2	18	0	2	20	4	22	6	24	8	26	10	28	13	31
11	109	24	6	22	4	20	2	18	0	2	20	4	22	6	24	8	26	10	28	12	30
12	108	23	5	22	4	20	2	18	0	2	20	4	22	5	23	7	25	9	27	12	30
13	107	23	5	21	3	20	2	18	0	2	20	3	21	5	23	7	25	9	27	11	29
14	106	23	5	21	3	20	2	18	0	2	20	3	21	5	23	7	25	9	27	11	29
15	105	23	5	21	3	20	2	18	0	2	20	3	21	5	23	6	24	8	26	10	28
16	104	23	5	21	3	19	1	18	0	1	19	3	21	5	23	6	24	8	26	10	28
17	103	22	4	21	3	19	1	18	0	1	19	3	21	4	22	6	24	8	26	9	27
18	102	22	4	21	3	19	1	18	0	1	19	3	21	4	22	6	24	7	25	9	27
19	101	22	4	21	3	19	1	18	0	1	19	3	21	4	22	5	23	7	25	8	26
20	100	22	4	20	2	19	1	18	0	1	19	2	20	4	22	5	23	7	25	8	26
21	99	22	4	20	2	19	1	18	0	1	19	2	20	4	22	5	23	6	24	8	26
22	98	21	3	20	2	19	1	18	0	1	19	2	20	3	21	5	23	6	24	7	25
23	97	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	6	24	7	25
24	96	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	5	23	7	25
25	95	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	5	23	6	24
26	94	21	3	20	2	19	1	18	0	1	19	2	20	3	21	4	22	5	23	6	24
27	93	21	3	20	2	19	1	18	0	1	19	2	20	3	21	3	21	4	22	5	23
28	92	20	2	20	2	19	1	18	0	1	19	2	20	2	20	3	21	4	22	5	23
29	91	20	2	19	1	19	1	18	0	1	19	1	19	2	20	3	21	4	22	5	23
30	90	20	2	19	1	19	1	18	0	1	19	1	19	2	20	3	21	4	22	5	23
31	89	20	2	19	1	19	1	18	0	1	19	1	19	2	20	3	21	3	21	4	22
32	38	20	2	19	1	19	1	18	0	1	19	1	19	2	20	2	20	3	21	4	22
33	87	20	2	19	1	19	1	18	0	1	19	1	19	2	20	2	20	3	21	4	22
34	86	20	2	19	1	19	1	18	0	1	19	1	19	2	20	2	20	3	21	3	21
35	85	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	3	21	3	21
36	84	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	2	20	3	21
37	83	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	2	20	3	21
38	82	19	1	19	1	18	0	18	0	0	18	1	19	1	19	2	20	2	20	2	20
39	81	19	1	19	1	13	0	18	0	0	18	1	19	1	19	1	19	2	20	2	20
40	80	19	1	19	1	18	0	18	0	0	18	1	19	1	19	1	19	2	20	2	20
41	79	19	1	19	1	18	0	18	0	0	18	1	19	1	19	1	19	1	19	2	20
42	78	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	2	20
43	77	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	1	19
44	76	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	1	19
45	75	19	1	18	0	18	0	18	0	0	18	0	18	1	19	1	19	1	19	1	19
46	74	18	0	18	0	18	0	18	0	0	18	0	13	0	18	1	19	1	19	1	19
47	73	18	0	18	0	18	0	18	0	0	18	0	18	0	18	1	19	1	19	1	19
48	72	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	1	19	1	19
49	71	18	0	18	0	18	0	13	0	0	18	0	18	0	18	0	18	0	18	1	19
50	70	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	1	19
52	68	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18
55	65	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18
60	60	18	0	18	0	18	0	18	0	0	18	0	18	0	18	0	18	0	18	0	18
		75° Tab.19.	75° Tab.19. +2Cor	80° Tab.19.	80° Tab.19. +2Cor	85° Tab.19.	85° Tab.19. +2Cor	90° Tab.19.	90° Tab.19. +2Cor	95° Tab.19.	95° Tab.19. +2Cor	100° Tab.19.	100° Tab.19. +2Cor	105° Tab.19.	105° Tab.19. +2Cor	110° Tab.19.	110° Tab.19. +2Cor	115° Tab.19.	115° Tab.19. +2Cor	120° Tab.19.	120° Tab.19. +2Cor

Apparent Distance.

TABLE XXI.

For turning Degrees and Minutes into Time, and the contrary.

D	HM	D	HM	D	HM	D	HM	D	HM	D	HM
M	MS	M	MS	M	MS	M	MS	M	MS	M	MS
1	0. 4	61	4. 4	121	8. 4	181	12. 4	241	16. 4	301	20. 4
2	0. 8	62	4. 8	122	8. 8	182	12. 8	242	16. 8	302	20. 8
3	0.12	63	4.12	123	8.12	183	12.12	243	16.12	303	20.12
4	0.16	64	4.16	124	8.16	184	12.16	244	16.16	304	20.16
5	0.20	65	4.20	125	8.20	185	12.20	245	16.20	305	20.20
6	0.24	66	4.24	126	8.24	186	12.24	246	16.24	306	20.24
7	0.28	67	4.28	127	8.28	187	12.28	247	16.28	307	20.28
8	0.32	68	4.32	128	8.32	188	12.32	248	16.32	308	20.32
9	0.36	69	4.36	129	8.36	189	12.36	249	16.36	309	20.36
10	0.40	70	4.40	130	8.40	190	12.40	250	16.40	310	20.40
11	0.44	71	4.44	131	8.44	191	12.44	251	16.44	311	20 44
12	0.48	72	4.48	132	8.48	192	12.48	252	16.48	312	20 48
13	0.52	73	4.52	133	8.52	193	12.52	253	16.52	313	20.52
14	0.56	74	4.56	134	8.56	194	12.56	254	16.56	314	20.56
15	1. 0	75	5. 0	135	9. 0	195	13. 0	255	17. 0	315	21. 0
16	1. 4	76	5. 4	136	9. 4	196	13. 4	256	17. 4	316	21. 4
17	1. 8	77	5. 8	137	9. 8	197	13. 8	257	17. 8	317	21. 8
18	1.12	78	5.12	138	9.12	198	13.12	258	17.12	318	21.12
19	1.16	79	5.16	139	9.16	199	13.16	259	17.16	319	21.16
20	1.20	80	5.20	140	9.20	200	13.20	260	17.20	320	21.20
21	1.24	81	5.24	141	9.24	201	13.24	261	17.24	321	21.24
22	1.28	82	5.28	142	9.28	202	13.28	262	17.28	322	21.28
23	1.32	83	5.32	143	9.32	203	13.32	263	17.32	323	21.32
24	1.36	84	5.36	144	9.36	204	13.36	264	17.36	324	21.36
25	1.40	85	5.40	145	9.40	205	13.40	265	17.40	325	21.40
26	1.44	86	5.44	146	9.44	206	13.44	266	17.44	326	21.44
27	1.48	87	5.48	147	9.48	207	13.48	267	17.48	327	21.48
28	1.52	88	5.52	148	9.52	208	13.52	268	17.52	328	21.52
29	1.56	89	5.56	149	9.56	209	13.56	269	17.56	329	21.56
30	2. 0	90	6. 0	150	10. 0	210	14. 0	270	18. 0	330	22. 0
31	2. 4	91	6. 4	151	10. 4	211	14. 4	271	18. 4	331	22. 4
32	2. 8	92	6. 8	152	10. 8	212	14. 8	272	18. 8	332	22. 8
33	2.12	93	6.12	153	10.12	213	14.12	273	18.12	333	22.12
34	2.16	94	6.16	154	10.16	214	14.16	274	18.16	334	22.16
35	2.20	95	6.20	155	10.20	215	14.20	275	18.20	335	22.20
36	2.24	96	6.24	156	10.24	216	14.24	276	18.24	336	22.24
37	2.28	97	6.28	157	10.28	217	14.28	277	18.28	337	22.28
38	2.32	98	6.32	158	10.32	218	14.32	278	18.32	338	22.32
39	2.36	99	6.36	159	10.36	219	14.36	279	18.36	339	22.36
40	2.40	100	6.40	160	10.40	220	14.40	280	18.40	340	22.40
41	2.44	101	6.44	161	10.44	221	14.44	281	18.44	341	22.44
42	2.48	102	6.48	162	10.48	222	14.48	282	18.48	342	22.48
43	2.52	103	6.52	163	10.52	223	14.52	283	18.52	343	22.52
44	2.56	104	6.56	164	10.56	224	14.56	284	18.56	344	22.56
45	3. 0	105	7. 0	165	11. 0	225	15. 0	285	19. 0	345	23. 0
46	3. 4	106	7. 4	166	11. 4	226	15. 4	286	19. 4	346	23. 4
47	3. 8	107	7. 8	167	11. 8	227	15. 8	287	19. 8	347	23. 8
48	3.12	108	7.12	168	11.12	228	15.12	288	19.12	348	23.12
49	3.16	109	7.16	169	11.16	229	15.16	289	19.16	349	23.16
50	3.20	110	7.20	170	11.20	230	15.20	290	19.20	350	23.20
51	3.24	111	7.24	171	11.24	231	15.24	291	19.24	351	23.24
52	3.28	112	7.28	172	11.28	232	15.28	292	19.28	352	23.28
53	3.32	113	7.32	173	11.32	233	15.32	293	19.32	353	23.32
54	3.36	114	7.36	174	11.36	234	15.36	294	19.36	354	23.36
55	3.40	115	7.40	175	11.40	235	15.40	295	19.40	355	23.40
56	3.44	116	7.44	176	11.44	236	15.44	296	19.44	356	23.44
57	3.48	117	7.48	177	11.48	237	15.48	297	19.48	357	23.48
58	3.52	118	7.52	178	11.52	238	15.52	298	19.52	358	23.52
59	3.56	119	7.56	179	11.56	239	15.56	299	19.56	359	23.56
60	4. 0	120	8. 0	180	12. 0	240	16. 0	300	20. 0	360	24. 0

PROPORTIONAL LOGARITHMS.

S.	h m 0° 0′	h m 0° 1′	h m 0° 2′	h m 0° 3′	h m 0° 4′	h m 0° 5′	h m 0° 6′	h m 0° 7′	h m 0° 8′	S.
0		2.2553	1.9542	1.7782	1.6532	1.5563	1.4771	1.4102	1.3522	0
1	4.0334	2.2481	1.9506	1.7757	1.6514	1.5549	1.4759	1.4091	1.3513	1
2	3.7324	2.2410	1.9471	1.7734	1.6496	1.5534	1.4747	1.4081	1.3504	2
3	3.5563	2.2341	1.9435	1.7710	1.6478	1.5520	1.4735	1.4071	1.3495	3
4	3.4314	2.2272	1.9400	1.7686	1.6460	1.5506	1.4723	1.4061	1.3486	4
5	3.3345	2.2205	1.9365	1.7663	1.6443	1.5491	1.4711	1.4050	1.3477	5
6	3.2553	2.2139	1.9331	1.7639	1.6425	1.5477	1.4699	1.4040	1.3468	6
7	3.1883	2.2073	1.9296	1.7616	1.6407	1.5463	1.4688	1.4030	1.3459	7
8	3.1303	2.2009	1.9262	1.7593	1.6390	1.5449	1.4676	1.4020	1.3450	8
9	3.0792	2.1946	1.9228	1.7570	1.6372	1.5435	1.4664	1.4010	1.3441	9
10	3.0334	2.1883	1.9195	1.7547	1.6355	1.5421	1.4652	1.4000	1.3432	10
11	2.9920	2.1822	1.9162	1.7524	1.6338	1.5407	1.4640	1.3989	1.3423	11
12	2.9542	2.1761	1.9128	1.7501	1.6320	1.5393	1.4629	1.3979	1.3415	12
13	2.9195	2.1701	1.9096	1.7479	1.6303	1.5379	1.4617	1.3969	1.3406	13
14	2.8873	2.1642	1.9063	1.7456	1.6286	1.5365	1.4606	1.3959	1.3397	14
15	2.8573	2.1584	1.9031	1.7434	1.6269	1.5351	1.4594	1.3949	1.3388	15
16	2.8293	2.1526	1.8999	1.7412	1.6252	1.5337	1.4582	1.3939	1.3379	16
17	2.8030	2.1469	1.8967	1.7390	1.6235	1.5324	1.4571	1.3929	1.3371	17
18	2.7782	2.1413	1.8935	1.7368	1.6218	1.5310	1.4559	1.3919	1.3362	18
19	2.7547	2.1358	1.8904	1.7346	1.6201	1.5296	1.4548	1.3910	1.3353	19
20	2.7324	2.1303	1.8873	1.7324	1.6185	1.5283	1.4536	1.3900	1.3345	20
21	2.7112	2.1249	1.8842	1.7302	1.6168	1.5269	1.4525	1.3890	1.3336	21
22	2.6910	2.1196	1.8811	1.7281	1.6151	1.5256	1.4514	1.3880	1.3327	22
23	2.6717	2.1143	1.8781	1.7259	1.6135	1.5242	1.4502	1.3870	1.3319	23
24	2.6532	2.1091	1.8751	1.7238	1.6118	1.5229	1.4491	1.3860	1.3310	24
25	2.6355	2.1040	1.8721	1.7217	1.6102	1.5215	1.4480	1.3851	1.3301	25
26	2.6185	2.0989	1.8691	1.7196	1.6085	1.5202	1.4468	1.3841	1.3293	26
27	2.6021	2.0939	1.8661	1.7175	1.6069	1.5189	1.4457	1.3831	1.3284	27
28	2.5863	2.0889	1.8632	1.7154	1.6053	1.5175	1.4446	1.3821	1.3276	28
29	2.5710	2.0840	1.8602	1.7133	1.6037	1.5162	1.4435	1.3812	1.3267	29
30	2.5563	2.0792	1.8573	1.7112	1.6021	1.5149	1.4424	1.3802	1.3259	30
31	2.5421	2.0744	1.8544	1.7091	1.6005	1.5136	1.4412	1.3792	1.3250	31
32	2.5283	2.0696	1.8516	1.7071	1.5989	1.5123	1.4401	1.3783	1.3242	32
33	2.5149	2.0649	1.8487	1.7050	1.5973	1.5110	1.4390	1.3773	1.3233	33
34	2.5019	2.0603	1.8459	1.7030	1.5957	1.5097	1.4379	1.3764	1.3225	34
35	2.4894	2.0557	1.8431	1.7010	1.5941	1.5084	1.4368	1.3754	1.3216	35
36	2.4771	2.0512	1.8403	1.6990	1.5925	1.5071	1.4357	1.3745	1.3208	36
37	2.4652	2.0467	1.8375	1.6970	1.5909	1.5058	1.4346	1.3735	1.3199	37
38	2.4536	2.0422	1.8348	1.6950	1.5894	1.5045	1.4335	1.3726	1.3191	38
39	2.4424	2.0378	1.8320	1.6930	1.5878	1.5032	1.4325	1.3716	1.3183	39
40	2.4314	2.0334	1.8293	1.6910	1.5863	1.5019	1.4314	1.3707	1.3174	40
41	2.4206	2.0291	1.8266	1.6890	1.5847	1.5007	1.4303	1.3697	1.3166	41
42	2.4102	2.0248	1.8239	1.6871	1.5832	1.4994	1.4292	1.3688	1.3158	42
43	2.4000	2.0206	1.8212	1.6851	1.5816	1.4981	1.4281	1.3678	1.3149	43
44	2.3900	2.0164	1.8186	1.6832	1.5801	1.4969	1.4270	1.3669	1.3141	44
45	2.3802	2.0122	1.8159	1.6812	1.5786	1.4956	1.4260	1.3660	1.3133	45
46	2.3707	2.0081	1.8133	1.6793	1.5771	1.4943	1.4249	1.3650	1.3124	46
47	2.3613	2.0040	1.8107	1.6774	1.5755	1.4931	1.4238	1.3641	1.3116	47
48	2.3522	2.0000	1.8081	1.6755	1.5740	1.4918	1.4228	1.3632	1.3108	48
49	2.3432	1.9960	1.8055	1.6736	1.5725	1.4906	1.4217	1.3623	1.3100	49
50	2.3345	1.9920	1.8030	1.6717	1.5710	1.4894	1.4206	1.3613	1.3091	50
51	2.3259	1.9881	1.8004	1.6698	1.5695	1.4881	1.4196	1.3604	1.3083	51
52	2.3174	1.9842	1.7979	1.6679	1.5680	1.4869	1.4185	1.3595	1.3075	52
53	2.3091	1.9803	1.7954	1.6661	1.5666	1.4856	1.4175	1.3586	1.3067	53
54	2.3010	1.9765	1.7929	1.6642	1.5651	1.4844	1.4164	1.3576	1.3059	54
55	2.2931	1.9727	1.7904	1.6624	1.5636	1.4832	1.4154	1.3567	1.3051	55
56	2.2852	1.9690	1.7879	1.6605	1.5621	1.4820	1.4143	1.3558	1.3043	56
57	2.2775	1.9652	1.7855	1.6587	1.5607	1.4808	1.4133	1.3549	1.3034	57
58	2.2700	1.9615	1.7830	1.6568	1.5592	1.4795	1.4122	1.3540	1.3026	58
59	2.2626	1.9579	1.7806	1.6550	1.5578	1.4783	1.4112	1.3531	1.3018	59
S.	0° 0′	0° 1′	0° 2′	0° 3′	0° 4′	0° 5′	0° 6′	0° 7′	0° 8′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 0° 9′	h m 0° 10′	h m 0° 11′	h m 0° 12′	h m 0° 13′	h m 0° 14′	h m 0° 15′	h m 0° 16′	h m 0° 17′	S.
0	1.3010	1.2553	1.2139	1.1761	1.1413	1.1091	1.0792	1.0512	1.0248	0
1	1.3002	1.2545	1.2132	1.1755	1.1408	1.1086	1.0787	1.0507	1.0244	1
2	1.2994	1.2538	1.2126	1.1749	1.1402	1.1081	1.0782	1.0502	1.0240	2
3	1.2986	1.2531	1.2119	1.1743	1.1397	1.1076	1.0777	1.0498	1.0235	3
4	1.2978	1.2524	1.2113	1.1737	1.1391	1.1071	1.0773	1.0493	1.0231	4
5	1.2970	1.2517	1.2106	1.1731	1.1386	1.1066	1.0768	1.0489	1.0227	5
6	1.2962	1.2510	1.2099	1.1725	1.1380	1.1061	1.0763	1.0484	1.0223	6
7	1.2954	1.2502	1.2093	1.1719	1.1374	1.1055	1.0758	1.0480	1.0219	7
8	1.2946	1.2495	1.2086	1.1713	1.1369	1.1050	1.0753	1.0475	1.0214	8
9	1.2939	1.2488	1.2080	1.1707	1.1363	1.1045	1.0749	1.0471	1.0210	9
10	1.2931	1.2481	1.2073	1.1701	1.1358	1.1040	1.0744	1.0467	1.0206	10
11	1.2923	1.2474	1.2067	1.1695	1.1352	1.1035	1.0739	1.0462	1.0202	11
12	1.2915	1.2467	1.2061	1.1689	1.1347	1.1030	1.0734	1.0458	1.0197	12
13	1.2907	1.2460	1.2054	1.1683	1.1342	1.1025	1.0730	1.0453	1.0193	13
14	1.2899	1.2453	1.2048	1.1677	1.1336	1.1020	1.0725	1.0449	1.0189	14
15	1.2891	1.2445	1.2041	1.1671	1.1331	1.1015	1.0720	1.0444	1.0185	15
16	1.2883	1.2438	1.2035	1.1665	1.1325	1.1009	1.0715	1.0440	1.0181	16
17	1.2876	1.2431	1.2028	1.1660	1.1320	1.1004	1.0711	1.0435	1.0176	17
18	1.2868	1.2424	1.2022	1.1654	1.1314	1.0999	1.0706	1.0431	1.0172	18
19	1.2860	1.2417	1.2016	1.1648	1.1309	1.0994	1.0701	1.0426	1.0168	19
20	1.2852	1.2410	1.2009	1.1642	1.1303	1.0989	1.0696	1.0422	1.0164	20
21	1.2845	1.2403	1.2003	1.1636	1.1298	1.0984	1.0692	1.0418	1.0160	21
22	1.2837	1.2396	1.1996	1.1630	1.1292	1.0979	1.0687	1.0413	1.0156	22
23	1.2829	1.2389	1.1990	1.1624	1.1287	1.0974	1.0682	1.0409	1.0151	23
24	1.2821	1.2382	1.1984	1.1619	1.1282	1.0969	1.0678	1.0404	1.0147	24
25	1.2814	1.2375	1.1977	1.1613	1.1276	1.0964	1.0673	1.0400	1.0143	25
26	1.2806	1.2368	1.1971	1.1607	1.1271	1.0959	1.0668	1.0395	1.0139	26
27	1.2798	1.2362	1.1965	1.1601	1.1266	1.0954	1.0663	1.0391	1.0135	27
28	1.2791	1.2355	1.1958	1.1595	1.1260	1.0949	1.0659	1.0387	1.0131	28
29	1.2783	1.2348	1.1952	1.1589	1.1255	1.0944	1.0654	1.0382	1.0126	29
30	1.2775	1.2341	1.1946	1.1584	1.1249	1.0939	1.0649	1.0378	1.0122	30
31	1.2768	1.2334	1.1939	1.1578	1.1244	1.0934	1.0645	1.0374	1.0118	31
32	1.2760	1.2327	1.1933	1.1572	1.1239	1.0929	1.0640	1.0369	1.0114	32
33	1.2753	1.2320	1.1927	1.1566	1.1233	1.0924	1.0635	1.0365	1.0110	33
34	1.2745	1.2313	1.1921	1.1561	1.1228	1.0919	1.0631	1.0360	1.0106	34
35	1.2738	1.2307	1.1914	1.1555	1.1223	1.0914	1.0626	1.0356	1.0102	35
36	1.2730	1.2300	1.1908	1.1549	1.1217	1.0909	1.0621	1.0352	1.0098	36
37	1.2722	1.2293	1.1902	1.1543	1.1212	1.0904	1.0617	1.0347	1.0093	37
38	1.2715	1.2286	1.1896	1.1538	1.1207	1.0899	1.0612	1.0343	1.0089	38
39	1.2707	1.2279	1.1889	1.1532	1.1201	1.0894	1.0608	1.0339	1.0085	39
40	1.2700	1.2272	1.1883	1.1526	1.1196	1.0889	1.0603	1.0334	1.0081	40
41	1.2692	1.2266	1.1877	1.1520	1.1191	1.0884	1.0598	1.0330	1.0077	41
42	1.2685	1.2259	1.1871	1.1515	1.1186	1.0880	1.0594	1.0326	1.0073	42
43	1.2678	1.2252	1.1865	1.1509	1.1180	1.0875	1.0589	1.0321	1.0069	43
44	1.2670	1.2245	1.1859	1.1503	1.1175	1.0870	1.0585	1.0317	1.0065	44
45	1.2663	1.2239	1.1852	1.1498	1.1170	1.0865	1.0580	1.0313	1.0061	45
46	1.2655	1.2232	1.1846	1.1492	1.1164	1.0860	1.0575	1.0308	1.0057	46
47	1.2648	1.2225	1.1840	1.1486	1.1159	1.0855	1.0571	1.0304	1.0053	47
48	1.2640	1.2218	1.1834	1.1481	1.1154	1.0850	1.0566	1.0300	1.0049	48
49	1.2633	1.2212	1.1828	1.1475	1.1149	1.0845	1.0562	1.0295	1.0044	49
50	1.2626	1.2205	1.1822	1.1469	1.1143	1.0840	1.0557	1.0291	1.0040	50
51	1.2618	1.2198	1.1816	1.1464	1.1138	1.0835	1.0552	1.0287	1.0036	51
52	1.2611	1.2192	1.1809	1.1458	1.1133	1.0831	1.0548	1.0282	1.0032	52
53	1.2604	1.2185	1.1803	1.1452	1.1128	1.0826	1.0543	1.0278	1.0028	53
54	1.2596	1.2178	1.1797	1.1447	1.1123	1.0821	1.0539	1.0274	1.0024	54
55	1.2589	1.2172	1.1791	1.1441	1.1117	1.0816	1.0534	1.0270	1.0020	55
56	1.2582	1.2165	1.1785	1.1436	1.1112	1.0811	1.0530	1.0265	1.0016	56
57	1.2574	1.2159	1.1779	1.1430	1.1107	1.0806	1.0525	1.0261	1.0012	57
58	1.2567	1.2152	1.1773	1.1424	1.1102	1.0801	1.0521	1.0257	1.0008	58
59	1.2560	1.2145	1.1767	1.1419	1.1097	1.0797	1.0516	1.0252	1.0004	59
S.	0° 9′	0° 10′	0° 11′	0° 12′	0° 13′	0° 14′	0° 15′	0° 16′	0° 17′	S.

PROPORTIONAL LOGARITHMS.

S.	h m 0° 18′	h m 0° 19′	h m 0° 20′	h m 0° 21′	h m 0° 22′	h m 0° 23′	h m 0° 24′	h m 0° 25′	h m 0° 26′	h m 0° 27′	h m 0° 28′	h m 0° 29′	S.
0	10000	9765	9542	9331	9128	8935	8751	8573	8403	8239	8081	7929	0
1	9996	9761	9539	9327	9125	8932	8748	8570	8400	8236	8079	7926	1
2	9992	9758	9535	9324	9122	8929	8745	8568	8397	8234	8076	7924	2
3	9988	9754	9532	9320	9119	8926	8742	8565	8395	8231	8073	7921	3
4	9984	9750	9528	9317	9115	8923	8739	8562	8392	8228	8071	7919	4
5	9980	9746	9524	9313	9112	8920	8736	8559	8389	8226	8068	7916	5
6	9976	9742	9521	9310	9109	8917	8733	8556	8386	8223	8066	7914	6
7	9972	9739	9517	9306	9106	8913	8730	8553	8384	8220	8063	7911	7
8	9968	9735	9514	9303	9102	8910	8727	8550	8381	8218	8061	7909	8
9	9964	9731	9510	9300	9099	8907	8724	8547	8378	8215	8058	7906	9
10	9960	9727	9506	9296	9096	8904	8721	8544	8375	8212	8055	7904	10
11	9956	9723	9503	9293	9092	8901	8718	8542	8372	8210	8053	7901	11
12	9952	9720	9499	9289	9089	8898	8715	8539	8370	8207	8050	7899	12
13	9948	9716	9496	9286	9086	8895	8712	8536	8367	8204	8048	7896	13
14	9944	9712	9492	9283	9083	8892	8709	8533	8364	8202	8045	7894	14
15	9940	9708	9488	9279	9079	8888	8706	8530	8361	8199	8043	7891	15
16	9936	9705	9485	9276	9076	8885	8703	8527	8359	8196	8040	7889	16
17	9932	9701	9481	9272	9073	8882	8700	8524	8356	8194	8037	7887	17
18	9928	9697	9478	9269	9070	8879	8697	8522	8353	8191	8035	7884	18
19	9924	9693	9474	9266	9066	8876	8694	8519	8350	8188	8032	7882	19
20	9920	9690	9471	9262	9063	8873	8691	8516	8348	8186	8030	7879	20
21	9916	9686	9467	9259	9060	8870	8688	8513	8345	8183	8027	7877	21
22	9912	9682	9464	9255	9057	8867	8685	8510	8342	8181	8025	7874	22
23	9908	9678	9460	9252	9053	8864	8682	8507	8339	8178	8022	7872	23
24	9905	9675	9456	9249	9050	8861	8679	8504	8337	8175	8020	7869	24
25	9901	9671	9453	9245	9047	8857	8676	8502	8334	8173	8017	7867	25
26	9897	9667	9449	9242	9044	8854	8673	8499	8331	8170	8014	7864	26
27	9893	9664	9446	9238	9041	8851	8670	8496	8328	8167	8012	7862	27
28	9889	9660	9442	9235	9037	8848	8667	8493	8326	8165	8009	7859	28
29	9885	9656	9439	9232	9034	8845	8664	8490	8323	8162	8007	7857	29
30	9881	9652	9435	9228	9031	8842	8661	8487	8320	8159	8004	7855	30
31	9877	9649	9432	9225	9028	8839	8658	8484	8318	8157	8002	7852	31
32	9873	9645	9428	9222	9024	8836	8655	8482	8315	8154	7999	7850	32
33	9869	9641	9425	9218	9021	8833	8652	8479	8312	8152	7997	7847	33
34	9865	9638	9421	9215	9018	8830	8649	8476	8309	8149	7994	7845	34
35	9861	9634	9418	9212	9015	8827	8646	8473	8307	8146	7992	7842	35
36	9858	9630	9414	9208	9012	8824	8643	8470	8304	8144	7989	7840	36
37	9854	9626	9411	9205	9008	8821	8640	8467	8301	8141	7987	7837	37
38	9850	9623	9407	9201	9005	8817	8637	8465	8298	8138	7984	7835	38
39	9846	9619	9404	9198	9002	8814	8635	8462	8296	8136	7981	7832	39
40	9842	9615	9400	9195	8999	8811	8632	8459	8293	8133	7979	7830	40
41	9838	9612	9397	9191	8996	8808	8629	8456	8290	8131	7976	7828	41
42	9834	9608	9393	9188	8992	8805	8626	8453	8288	8128	7974	7825	42
43	9830	9604	9390	9185	8989	8802	8623	8451	8285	8125	7971	7823	43
44	9827	9601	9386	9181	8986	8799	8620	8448	8282	8123	7969	7820	44
45	9823	9597	9383	9178	8983	8796	8617	8445	8279	8120	7966	7818	45
46	9819	9593	9379	9175	8980	8793	8614	8442	8277	8117	7964	7815	46
47	9815	9590	9376	9171	8977	8790	8611	8439	8274	8115	7961	7813	47
48	9811	9586	9372	9168	8973	8787	8608	8437	8271	8112	7959	7811	48
49	9807	9582	9369	9165	8970	8784	8605	8434	8269	8110	7956	7808	49
50	9803	9579	9365	9162	8967	8781	8602	8431	8266	8107	7954	7806	50
51	9800	9575	9362	9158	8964	8778	8599	8428	8263	8104	7951	7803	51
52	9796	9571	9358	9155	8961	8775	8597	8425	8261	8102	7949	7801	52
53	9792	9568	9355	9152	8958	8772	8594	8423	8258	8099	7946	7798	53
54	9788	9564	9351	9148	8954	8769	8591	8420	8255	8097	7944	7796	54
55	9784	9561	9348	9145	8951	8766	8588	8417	8253	8094	7941	7794	55
56	9780	9557	9344	9142	8948	8763	8585	8414	8250	8091	7939	7791	56
57	9777	9553	9341	9138	8945	8760	8582	8411	8247	8089	7936	7789	57
58	9773	9550	9337	9135	8942	8757	8579	8409	8244	8086	7934	7786	58
59	9769	9546	9334	9132	8939	8754	8576	8406	8242	8084	7931	7784	59
S.	0° 18′	0° 19′	0° 20′	0° 21′	0° 22′	0° 23′	0° 24′	0° 25′	0° 26′	0° 27′	0° 28′	0° 29′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 0° 30′	h m 0° 31′	h m 0° 32′	h m 0° 33′	h m 0° 34′	h m 0° 35′	h m 0° 36′	h m 0° 37′	h m 0° 38′	h m 0° 39′	h m 0° 40′	h m 0° 41′	S.
0	7782	7639	7501	7368	7238	7112	6990	6871	6755	6642	6532	6425	0
1	7779	7637	7499	7365	7236	7110	6988	6869	6753	6640	6530	6423	1
2	7777	7634	7497	7363	7234	7108	6986	6867	6751	6638	6529	6421	2
3	7774	7632	7494	7361	7232	7106	6984	6865	6749	6637	6527	6420	3
4	7772	7630	7492	7359	7229	7104	6982	6863	6747	6635	6525	6418	4
5	7769	7627	7490	7357	7227	7102	6980	6861	6745	6633	6523	6416	5
6	7767	7625	7488	7354	7225	7100	6978	6859	6743	6631	6521	6414	6
7	7765	7623	7485	7352	7223	7098	6976	6857	6742	6629	6519	6413	7
8	7762	7620	7483	7350	7221	7096	6974	6855	6740	6627	6518	6411	8
9	7760	7618	7481	7348	7219	7093	6972	6853	6738	6625	6516	6409	9
10	7757	7616	7479	7346	7217	7091	6970	6851	6736	6624	6514	6407	10
11	7755	7613	7476	7344	7215	7089	6968	6849	6734	6622	6512	6406	11
12	7753	7611	7474	7341	7212	7087	6966	6847	6732	6620	6510	6404	12
13	7750	7609	7472	7339	7210	7085	6964	6845	6730	6618	6509	6402	13
14	7748	7607	7470	7337	7208	7083	6962	6843	6728	6616	6507	6400	14
15	7745	7604	7467	7335	7206	7081	6960	6841	6726	6614	6505	6398	15
16	7743	7602	7465	7333	7204	7079	6958	6840	6725	6612	6503	6397	16
17	7741	7600	7463	7330	7202	7077	6956	6838	6723	6611	6501	6395	17
18	7738	7597	7461	7328	7200	7075	6954	6836	6721	6609	6500	6393	18
19	7736	7595	7458	7326	7198	7073	6952	6834	6719	6607	6498	6391	19
20	7734	7593	7456	7324	7195	7071	6950	6832	6717	6605	6496	6390	20
21	7731	7590	7454	7322	7193	7069	6948	6830	6715	6603	6494	6388	21
22	7729	7588	7452	7320	7191	7067	6946	6828	6713	6601	6492	6386	22
23	7726	7586	7450	7317	7189	7065	6944	6826	6711	6600	6491	6384	23
24	7724	7583	7447	7315	7187	7063	6942	6824	6709	6598	6489	6383	24
25	7722	7581	7445	7313	7185	7061	6940	6822	6708	6596	6487	6381	25
26	7719	7579	7443	7311	7183	7059	6938	6820	6706	6594	6485	6379	26
27	7717	7577	7441	7309	7181	7057	6936	6818	6704	6592	6484	6377	27
28	7714	7574	7438	7307	7179	7055	6934	6816	6702	6590	6482	6376	28
29	7712	7572	7436	7304	7177	7052	6932	6814	6700	6589	6480	6374	29
30	7710	7570	7434	7302	7175	7050	6930	6812	6698	6587	6478	6372	30
31	7707	7567	7432	7300	7172	7048	6928	6810	6696	6585	6476	6371	31
32	7705	7565	7429	7298	7170	7046	6926	6809	6694	6583	6475	6369	32
33	7703	7563	7427	7296	7168	7044	6924	6807	6692	6581	6473	6367	33
34	7700	7560	7425	7294	7166	7042	6922	6805	6691	6579	6471	6365	34
35	7698	7558	7423	7291	7164	7040	6920	6803	6689	6578	6469	6364	35
36	7696	7556	7421	7289	7162	7038	6918	6801	6687	6576	6467	6362	36
37	7693	7554	7418	7287	7160	7036	6916	6799	6685	6574	6466	6360	37
38	7691	7551	7416	7285	7158	7034	6914	6797	6683	6572	6464	6358	38
39	7688	7549	7414	7283	7156	7032	6912	6795	6681	6570	6462	6357	39
40	7686	7547	7412	7281	7154	7030	6910	6793	6679	6568	6460	6355	40
41	7684	7544	7409	7279	7152	7028	6908	6791	6677	6567	6459	6353	41
42	7681	7542	7407	7276	7149	7026	6906	6789	6676	6565	6457	6351	42
43	7679	7540	7405	7274	7147	7024	6904	6787	6674	6563	6455	6350	43
44	7677	7538	7403	7272	7145	7022	6902	6785	6672	6561	6453	6348	44
45	7674	7535	7401	7270	7143	7020	6900	6784	6670	6559	6451	6346	45
46	7672	7533	7398	7268	7141	7018	6898	6782	6668	6558	6450	6344	46
47	7670	7531	7396	7266	7139	7016	6896	6780	6666	6556	6448	6343	47
48	7667	7528	7394	7264	7137	7014	6894	6778	6664	6554	6446	6341	48
49	7665	7526	7392	7261	7135	7012	6892	6776	6663	6552	6444	6339	49
50	7663	7524	7390	7259	7133	7010	6890	6774	6661	6550	6443	6338	50
51	7660	7522	7387	7257	7131	7008	6888	6772	6659	6548	6441	6336	51
52	7658	7519	7385	7255	7129	7006	6886	6770	6657	6547	6439	6334	52
53	7655	7517	7383	7253	7127	7004	6884	6768	6655	6545	6437	6332	53
54	7653	7515	7381	7251	7124	7002	6882	6766	6653	6543	6435	6331	54
55	7651	7513	7379	7249	7122	7000	6881	6764	6651	6541	6434	6329	55
56	7648	7510	7376	7246	7120	6998	6879	6763	6650	6539	6432	6327	56
57	7646	7508	7374	7244	7118	6996	6877	6761	6648	6538	6430	6325	57
58	7644	7506	7372	7242	7116	6994	6875	6759	6646	6536	6428	6324	58
59	7611	7503	7370	7240	7114	6992	6873	6757	6644	6534	6427	6322	59
S.	0° 30′	0° 31′	0° 32′	0° 33′	0° 34′	0° 35′	0° 36′	0° 37′	0° 38′	0° 39′	0° 40′	0° 41′	S.

PROPORTIONAL LOGARITHMS.

S.	h m 0° 42′	h m 0° 43′	h m 0° 44′	h m 0° 45′	h m 0° 46′	h m 0° 47′	h m 0° 48′	h m 0° 49′	h m 0° 50′	h m 0° 51′	h m 0° 52′	h m 0° 53′	S.
0	6320	6218	6118	6021	5925	5832	5740	5651	5563	5477	5393	5310	0
1	6319	6216	6117	6019	5924	5830	5739	5649	5562	5476	5391	5309	1
2	6317	6215	6115	6017	5922	5829	5737	5648	5560	5474	5390	5307	2
3	6315	6213	6113	6016	5920	5827	5736	5646	5559	5473	5389	5306	3
4	6313	6211	6112	6014	5919	5826	5734	5645	5557	5471	5387	5305	4
5	6312	6210	6110	6013	5917	5824	5733	5643	5556	5470	5386	5303	5
6	6310	6208	6108	6011	5916	5823	5731	5642	5554	5469	5384	5302	6
7	6308	6206	6107	6009	5914	5821	5730	5640	5553	5467	5383	5300	7
8	6306	6205	6105	6008	5913	5819	5728	5639	5551	5466	5382	5299	8
9	6305	6203	6103	6006	5911	5818	5727	5637	5550	5464	5380	5298	9
10	6303	6201	6102	6005	5909	5816	5725	5636	5549	5463	5379	5296	10
11	6301	6200	6100	6003	5908	5815	5724	5635	5547	5461	5377	5295	11
12	6300	6198	6099	6001	5906	5813	5722	5633	5546	5460	5376	5294	12
13	6298	6196	6097	6000	5905	5812	5721	5632	5544	5459	5375	5292	13
14	6296	6195	6095	5998	5903	5810	5719	5630	5543	5457	5373	5291	14
15	6294	6193	6094	5997	5902	5809	5718	5629	5541	5456	5372	5290	15
16	6293	6191	6092	5995	5900	5807	5716	5627	5540	5454	5370	5288	16
17	6291	6190	6090	5993	5898	5806	5715	5626	5538	5453	5369	5287	17
18	6289	6188	6089	5992	5897	5804	5713	5624	5537	5452	5368	5285	18
19	6288	6186	6087	5990	5895	5803	5712	5623	5536	5450	5366	5284	19
20	6286	6185	6085	5989	5894	5801	5710	5621	5534	5449	5365	5283	20
21	6284	6183	6084	5987	5892	5800	5709	5620	5533	5447	5364	5281	21
22	6282	6181	6082	5985	5891	5798	5707	5618	5531	5446	5362	5280	22
23	6281	6179	6081	5984	5889	5796	5706	5617	5530	5445	5361	5279	23
24	6279	6178	6079	5982	5888	5795	5704	5615	5528	5443	5359	5277	24
25	6277	6176	6077	5981	5886	5793	5703	5614	5527	5442	5358	5276	25
26	6276	6174	6076	5979	5884	5792	5701	5613	5526	5440	5357	5275	26
27	6274	6173	6074	5977	5883	5790	5700	5611	5524	5439	5355	5273	27
28	6272	6171	6072	5976	5881	5789	5698	5610	5523	5437	5354	5272	28
29	6271	6169	6071	5974	5880	5787	5697	5608	5521	5436	5353	5271	29
30	6269	6168	6069	5973	5878	5786	5695	5607	5520	5435	5351	5269	30
31	6267	6166	6067	5971	5877	5784	5694	5605	5518	5433	5350	5268	31
32	6265	6165	6066	5969	5875	5783	5692	5604	5517	5432	5348	5266	32
33	6264	6163	6064	5968	5874	5781	5691	5602	5516	5430	5347	5265	33
34	6262	6161	6063	5966	5872	5780	5689	5601	5514	5429	5346	5264	34
35	6260	6160	6061	5965	5870	5778	5688	5599	5513	5428	5344	5262	35
36	6259	6158	6059	5963	5869	5777	5686	5598	5511	5426	5343	5261	36
37	6257	6156	6058	5961	5867	5775	5685	5596	5510	5425	5341	5260	37
38	6255	6155	6056	5960	5866	5774	5683	5595	5508	5423	5340	5258	38
39	6254	6153	6055	5958	5864	5772	5682	5594	5507	5422	5339	5257	39
40	6252	6151	6053	5957	5863	5771	5680	5592	5506	5421	5337	5256	40
41	6250	6150	6051	5955	5861	5769	5679	5591	5504	5419	5336	5254	41
42	6248	6148	6050	5954	5860	5768	5677	5589	5503	5418	5335	5253	42
43	6247	6146	6048	5952	5858	5766	5676	5588	5501	5416	5333	5252	43
44	6245	6145	6046	5950	5856	5765	5674	5586	5500	5415	5332	5250	44
45	6243	6143	6045	5949	5855	5763	5673	5585	5498	5414	5331	5249	45
46	6242	6141	6043	5947	5853	5761	5671	5583	5497	5412	5329	5248	46
47	6240	6140	6042	5946	5852	5760	5670	5582	5496	5411	5328	5246	47
48	6238	6138	6040	5944	5850	5758	5669	5580	5494	5409	5326	5245	48
49	6237	6136	6038	5942	5849	5757	5667	5579	5493	5408	5325	5244	49
50	6235	6135	6037	5941	5847	5755	5666	5578	5491	5407	5324	5242	50
51	6233	6133	6035	5939	5846	5754	5664	5576	5490	5405	5322	5241	51
52	6232	6131	6033	5938	5844	5752	5663	5575	5488	5404	5321	5240	52
53	6230	6130	6032	5936	5843	5751	5661	5573	5487	5402	5320	5238	53
54	6228	6128	6030	5935	5841	5749	5660	5572	5486	5401	5318	5237	54
55	6226	6126	6029	5933	5839	5748	5658	5570	5484	5400	5317	5235	55
56	6225	6125	6027	5931	5838	5746	5657	5569	5483	5398	5315	5234	56
57	6223	6123	6025	5930	5836	5745	5655	5567	5481	5397	5314	5233	57
58	6221	6121	6024	5928	5835	5743	5654	5566	5480	5395	5313	5231	58
59	6220	6120	6022	5927	5833	5742	5652	5564	5478	5394	5311	5230	59
S.	0° 42′	0° 43′	0° 44′	0° 45′	0° 46′	0° 47′	0° 48′	0° 49′	0° 50′	0° 51′	0° 52′	0° 53′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 0° 54′	h m 0° 55′	h m 0° 56′	h m 0° 57′	h m 0° 58′	h m 0° 59′	h m 1° 0′	h m 1° 1′	h m 1° 2′	h m 1° 3′	h m 1° 4′	h m 1° 5′	S.
0	5229	5149	5071	4994	4918	4844	4771	4699	4629	4559	4491	4424	0
1	5227	5148	5070	4993	4917	4843	4770	4698	4628	4558	4490	4422	1
2	5226	5146	5068	4991	4916	4842	4769	4697	4626	4557	4489	4421	2
3	5225	5145	5067	4990	4915	4841	4768	4696	4625	4556	4488	4420	3
4	5223	5144	5066	4989	4913	4839	4766	4695	4624	4555	4486	4419	4
5	5222	5143	5064	4988	4912	4838	4765	4693	4623	4554	4485	4418	5
6	5221	5141	5063	4986	4911	4837	4764	4692	4622	4552	4484	4417	6
7	5219	5140	5062	4985	4910	4836	4763	4691	4621	4551	4483	4416	7
8	5218	5139	5061	4984	4908	4834	4762	4690	4619	4550	4482	4415	8
9	5217	5137	5059	4983	4907	4833	4760	4689	4618	4549	4481	4414	9
10	5215	5136	5058	4981	4906	4832	4759	4688	4617	4548	4480	4412	10
11	5214	5135	5057	4980	4905	4831	4758	4686	4616	4547	4479	4411	11
12	5213	5133	5055	4979	4903	4830	4757	4685	4615	4546	4477	4410	12
13	5211	5132	5054	4977	4902	4828	4756	4684	4614	4544	4476	4409	13
14	5210	5131	5053	4976	4901	4827	4754	4683	4612	4543	4475	4408	14
15	5209	5129	5051	4975	4900	4826	4753	4682	4611	4542	4474	4407	15
16	5207	5128	5050	4974	4899	4825	4752	4680	4610	4541	4473	4406	16
17	5206	5127	5049	4972	4897	4823	4751	4679	4609	4540	4472	4405	17
18	5205	5125	5048	4971	4896	4822	4750	4678	4608	4539	4471	4404	18
19	5203	5124	5046	4970	4895	4821	4748	4677	4607	4538	4469	4402	19
20	5202	5123	5045	4969	4894	4820	4747	4676	4606	4536	4468	4401	20
21	5201	5122	5044	4967	4892	4819	4746	4675	4604	4535	4467	4400	21
22	5199	5120	5043	4966	4891	4817	4745	4673	4603	4534	4466	4399	22
23	5198	5119	5041	4965	4890	4816	4744	4672	4602	4533	4465	4398	23
24	5197	5118	5040	4964	4889	4815	4742	4671	4601	4532	4464	4397	24
25	5195	5116	5039	4962	4887	4814	4741	4670	4600	4531	4463	4396	25
26	5194	5115	5037	4961	4886	4812	4740	4669	4599	4530	4462	4395	26
27	5193	5114	5036	4960	4885	4811	4739	4668	4597	4528	4460	4394	27
28	5191	5112	5035	4959	4884	4810	4738	4666	4596	4527	4459	4393	28
29	5190	5111	5034	4957	4882	4809	4736	4665	4595	4526	4458	4391	29
30	5189	5110	5032	4956	4881	4808	4735	4664	4594	4525	4457	4390	30
31	5187	5108	5031	4955	4880	4806	4734	4663	4593	4524	4456	4389	31
32	5186	5107	5030	4954	4879	4805	4733	4662	4592	4523	4455	4388	32
33	5185	5106	5028	4952	4877	4804	4732	4660	4590	4522	4454	4387	33
34	5183	5105	5027	4951	4876	4803	4730	4659	4589	4520	4453	4386	34
35	5182	5103	5026	4950	4875	4801	4729	4658	4588	4519	4452	4385	35
36	5181	5102	5025	4949	4874	4800	4728	4657	4587	4518	4450	4384	36
37	5179	5101	5023	4947	4873	4799	4727	4656	4586	4517	4449	4383	37
38	5178	5099	5022	4946	4871	4798	4726	4655	4585	4516	4448	4381	38
39	5177	5098	5021	4945	4870	4797	4724	4653	4584	4515	4447	4380	39
40	5175	5097	5019	4943	4869	4795	4723	4652	4582	4514	4446	4379	40
41	5174	5095	5018	4942	4868	4794	4722	4651	4581	4512	4445	4378	41
42	5173	5094	5017	4941	4866	4793	4721	4650	4580	4511	4444	4377	42
43	5172	5093	5016	4940	4865	4792	4720	4649	4579	4510	4443	4376	43
44	5170	5092	5014	4938	4864	4791	4718	4648	4578	4509	4441	4375	44
45	5169	5090	5013	4937	4863	4789	4717	4646	4577	4508	4440	4374	45
46	5168	5089	5012	4936	4861	4788	4716	4645	4575	4507	4439	4373	46
47	5166	5088	5011	4935	4860	4787	4715	4644	4574	4506	4438	4372	47
48	5165	5086	5009	4933	4859	4786	4714	4643	4573	4505	4437	4370	48
49	5164	5085	5008	4932	4858	4785	4712	4642	4572	4503	4436	4369	49
50	5162	5084	5007	4931	4856	4783	4711	4640	4571	4502	4435	4368	50
51	5161	5082	5005	4930	4855	4782	4710	4639	4570	4501	4434	4367	51
52	5160	5081	5004	4928	4854	4781	4709	4638	4569	4500	4433	4366	52
53	5158	5080	5003	4927	4853	4780	4708	4637	4567	4499	4431	4365	53
54	5157	5079	5002	4926	4852	4778	4707	4636	4566	4498	4430	4364	54
55	5156	5077	5000	4925	4850	4777	4705	4635	4565	4497	4429	4363	55
56	5154	5076	4999	4923	4849	4776	4704	4633	4564	4495	4428	4362	56
57	5153	5075	4998	4922	4848	4775	4703	4632	4563	4494	4427	4361	57
58	5152	5073	4997	4921	4847	4774	4702	4631	4562	4493	4426	4359	58
59	5150	5072	4995	4920	4845	4772	4701	4630	4560	4492	4425	4358	59
S.	0° 54′	0° 55′	0° 56′	0° 57′	0° 58′	0° 59′	1° 0′	1° 1′	1° 2′	1° 3′	1° 4′	1° 5′	S.

PROPORTIONAL LOGARITHMS.

S.	h m 1° 6′	h m 1° 7′	h m 1° 8′	h m 1° 9′	h m 1° 10′	h m 1° 11′	h m 1° 12′	h m 1° 13′	h m 1° 14′	h m 1° 15′	h m 1° 16′	h m 1° 17′	S.
0	4357	4292	4228	4164	4102	4040	3979	3919	3860	3802	3745	3688	0
1	4356	4291	4227	4163	4101	4039	3978	3919	3859	3801	3744	3687	1
2	4355	4290	4226	4162	4100	4038	3977	3918	3858	3800	3743	3686	2
3	4354	4289	4224	4161	4099	4037	3976	3917	3857	3799	3742	3685	3
4	4353	4288	4223	4160	4098	4036	3975	3916	3856	3798	3741	3684	4
5	4352	4287	4222	4159	4097	4035	3974	3915	3856	3797	3740	3683	5
6	4351	4285	4221	4158	4096	4034	3973	3914	3855	3796	3739	3682	6
7	4350	4284	4220	4157	4095	4033	3972	3913	3854	3795	3738	3681	7
8	4349	4283	4219	4156	4093	4032	3971	3912	3853	3794	3737	3680	8
9	4347	4282	4218	4155	4092	4031	3970	3911	3852	3793	3736	3679	9
10	4346	4281	4217	4154	4091	4030	3969	3910	3851	3792	3735	3678	10
11	4345	4280	4216	4153	4090	4029	3968	3909	3850	3792	3734	3677	11
12	4344	4279	4215	4152	4089	4028	3967	3908	3849	3791	3733	3677	12
13	4343	4278	4214	4151	4088	4027	3966	3907	3848	3790	3732	3676	13
14	4342	4277	4213	4150	4087	4026	3965	3906	3847	3789	3731	3675	14
15	4341	4276	4212	4149	4086	4025	3964	3905	3846	3788	3730	3674	15
16	4340	4275	4211	4147	4085	4024	3963	3904	3845	3787	3729	3673	16
17	4339	4274	4210	4146	4084	4023	3962	3903	3844	3786	3728	3672	17
18	4338	4273	4209	4145	4083	4022	3961	3902	3843	3785	3727	3671	18
19	4336	4271	4207	4144	4082	4021	3960	3901	3842	3784	3727	3670	19
20	4335	4270	4206	4143	4081	4020	3959	3900	3841	3783	3726	3669	20
21	4334	4269	4205	4142	4080	4019	3958	3899	3840	3782	3725	3668	21
22	4333	4268	4204	4141	4079	4018	3957	3898	3839	3781	3724	3667	22
23	4332	4267	4203	4140	4078	4017	3956	3897	3838	3780	3723	3666	23
24	4331	4266	4202	4139	4077	4016	3955	3896	3837	3779	3722	3665	24
25	4330	4265	4201	4138	4076	4015	3954	3895	3836	3778	3721	3664	25
26	4329	4264	4200	4137	4075	4014	3953	3894	3835	3777	3720	3663	26
27	4328	4263	4199	4136	4074	4013	3952	3893	3834	3776	3719	3663	27
28	4327	4262	4198	4135	4073	4012	3951	3892	3833	3775	3718	3662	28
29	4326	4261	4197	4134	4072	4011	3950	3891	3832	3774	3717	3661	29
30	4325	4260	4196	4133	4071	4010	3949	3890	3831	3773	3716	3660	30
31	4323	4259	4195	4132	4070	4009	3948	3889	3830	3772	3715	3659	31
32	4322	4258	4194	4131	4069	4008	3947	3888	3829	3771	3714	3658	32
33	4321	4256	4193	4130	4068	4007	3946	3887	3828	3770	3713	3657	33
34	4320	4255	4192	4129	4067	4006	3945	3886	3827	3769	3712	3656	34
35	4319	4254	4191	4128	4066	4005	3944	3885	3826	3768	3711	3655	35
36	4318	4253	4189	4127	4065	4004	3943	3884	3825	3768	3710	3654	36
37	4317	4252	4188	4126	4064	4003	3942	3883	3824	3767	3709	3653	37
38	4316	4251	4187	4125	4063	4002	3941	3882	3823	3766	3709	3652	38
39	4315	4250	4186	4124	4062	4001	3940	3881	3822	3765	3708	3651	39
40	4314	4249	4185	4122	4061	4000	3939	3880	3821	3764	3707	3650	40
41	4313	4248	4184	4121	4060	3999	3938	3879	3820	3763	3706	3649	41
42	4311	4247	4183	4120	4059	3998	3937	3878	3820	3762	3705	3649	42
43	4310	4246	4182	4119	4058	3997	3936	3877	3819	3761	3704	3648	43
44	4309	4245	4181	4118	4056	3996	3935	3876	3818	3760	3703	3647	44
45	4308	4244	4180	4117	4055	3995	3934	3875	3817	3759	3702	3646	45
46	4307	4243	4179	4116	4054	3993	3933	3874	3816	3758	3701	3645	46
47	4306	4241	4178	4115	4053	3992	3932	3873	3815	3757	3700	3644	47
48	4305	4240	4177	4114	4052	3991	3931	3872	3814	3756	3699	3643	48
49	4304	4239	4176	4113	4051	3990	3930	3871	3813	3755	3698	3642	49
50	4303	4238	4175	4112	4050	3989	3929	3870	3812	3754	3697	3641	50
51	4302	4237	4174	4111	4049	3988	3928	3869	3811	3753	3696	3640	51
52	4301	4236	4173	4110	4048	3987	3927	3868	3810	3752	3695	3639	52
53	4300	4235	4172	4109	4047	3986	3926	3867	3809	3751	3694	3638	53
54	4298	4234	4171	4108	4046	3985	3925	3866	3808	3750	3693	3637	54
55	4297	4233	4169	4107	4045	3984	3924	3865	3807	3749	3693	3636	55
56	4296	4232	4168	4106	4044	3983	3923	3864	3806	3748	3692	3635	56
57	4295	4231	4167	4105	4043	3982	3922	3863	3805	3747	3691	3635	57
58	4294	4230	4166	4104	4042	3981	3921	3862	3804	3746	3690	3634	58
59	4293	4229	4165	4103	4041	3980	3920	3861	3803	3746	3689	3633	59
S.	1° 6′	1° 7′	1° 8′	1° 9′	1° 10′	1° 11′	1° 12′	1° 13′	1° 14′	1° 15′	1° 16′	1° 17′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 1° 18′	h m 1° 19′	h m 1° 20′	h m 1° 21′	h m 1° 22′	h m 1° 23′	h m 1° 24′	h m 1° 25′	h m 1° 26′	h m 1° 27′	h m 1° 28′	h m 1° 29′	S.
0	3632	3576	3522	3468	3415	3362	3310	3259	3208	3158	3108	3059	0
1	3631	3576	3521	3467	3414	3361	3309	3258	3207	3157	3107	3058	1
2	3630	3575	3520	3466	3413	3360	3308	3257	3206	3156	3106	3057	2
3	3629	3574	3519	3465	3412	3359	3307	3256	3205	3155	3105	3056	3
4	3628	3573	3518	3464	3411	3358	3306	3255	3204	3154	3105	3056	4
5	3627	3572	3517	3463	3410	3358	3306	3254	3204	3153	3104	3055	5
6	3626	3571	3516	3463	3409	3357	3305	3253	3203	3153	3103	3054	6
7	3625	3570	3515	3462	3408	3356	3304	3253	3202	3152	3102	3053	7
8	3624	3569	3515	3461	3408	3355	3303	3252	3201	3151	3101	3052	8
9	3623	3568	3514	3460	3407	3354	3302	3251	3200	3150	3101	3052	9
10	3623	3567	3513	3459	3406	3353	3301	3250	3199	3149	3100	3051	10
11	3622	3566	3512	3458	3405	3352	3300	3249	3198	3148	3099	3050	11
12	3621	3565	3511	3457	3404	3351	3300	3248	3198	3148	3098	3049	12
13	3620	3565	3510	3456	3403	3351	3299	3247	3197	3147	3097	3048	13
14	3619	3564	3509	3455	3402	3350	3298	3247	3196	3146	3096	3047	14
15	3618	3563	3508	3454	3401	3349	3297	3246	3195	3145	3096	3047	15
16	3617	3562	3507	3454	3400	3348	3296	3245	3194	3144	3095	3046	16
17	3616	3561	3506	3453	3400	3347	3295	3244	3193	3143	3094	3045	17
18	3615	3560	3506	3452	3399	3346	3294	3243	3193	3143	3093	3044	18
19	3614	3559	3505	3451	3398	3345	3294	3242	3192	3142	3092	3043	19
20	3613	3558	3504	3450	3397	3345	3293	3242	3191	3141	3091	3043	20
21	3612	3557	3503	3449	3396	3344	3292	3241	3190	3140	3091	3042	21
22	3611	3556	3502	3448	3395	3343	3291	3240	3189	3139	3090	3041	22
23	3610	3555	3501	3447	3394	3342	3290	3239	3188	3138	3089	3040	23
24	3610	3555	3500	3446	3393	3341	3289	3238	3188	3138	3088	3039	24
25	3609	3554	3499	3446	3393	3340	3288	3237	3187	3137	3087	3039	25
26	3608	3553	3498	3445	3392	3339	3288	3236	3186	3136	3087	3038	26
27	3607	3552	3497	3444	3391	3338	3287	3236	3185	3135	3086	3037	27
28	3606	3551	3497	3443	3390	3338	3286	3235	3184	3134	3085	3036	28
29	3605	3550	3496	3442	3389	3337	3285	3234	3183	3133	3084	3035	29
30	3604	3549	3495	3441	3388	3336	3284	3233	3183	3133	3083	3034	30
31	3603	3548	3494	3440	3387	3335	3283	3232	3182	3132	3082	3034	31
32	3602	3547	3493	3439	3386	3334	3282	3231	3181	3131	3082	3033	32
33	3601	3546	3492	3438	3386	3333	3282	3231	3180	3130	3081	3032	33
34	3600	3545	3491	3438	3385	3332	3281	3230	3179	3129	3080	3031	34
35	3599	3545	3490	3437	3384	3332	3280	3229	3178	3129	3079	3030	35
36	3598	3544	3489	3436	3383	3331	3279	3228	3178	3128	3078	3030	36
37	3598	3543	3488	3435	3382	3330	3278	3227	3177	3127	3078	3029	37
38	3597	3542	3488	3434	3381	3329	3277	3226	3176	3126	3077	3028	38
39	3596	3541	3487	3433	3380	3328	3276	3225	3175	3125	3076	3027	39
40	3595	3540	3486	3432	3379	3327	3276	3225	3174	3124	3075	3026	40
41	3594	3539	3485	3431	3379	3326	3275	3224	3173	3124	3074	3026	41
42	3593	3538	3484	3431	3378	3325	3274	3223	3173	3123	3073	3025	42
43	3592	3537	3483	3430	3377	3325	3273	3222	3172	3122	3073	3024	43
44	3591	3536	3482	3429	3376	3324	3272	3221	3171	3121	3072	3023	44
45	3590	3535	3481	3428	3375	3323	3271	3220	3170	3120	3071	3022	45
46	3589	3535	3480	3427	3374	3322	3270	3220	3169	3119	3070	3022	46
47	3588	3534	3480	3426	3373	3321	3270	3219	3168	3119	3069	3021	47
48	3587	3533	3479	3425	3372	3320	3269	3218	3168	3118	3069	3020	48
49	3587	3532	3478	3424	3372	3319	3268	3217	3167	3117	3068	3019	49
50	3586	3531	3477	3423	3371	3319	3267	3216	3166	3116	3067	3018	50
51	3585	3530	3476	3423	3370	3318	3266	3215	3165	3115	3066	3018	51
52	3584	3529	3475	3422	3369	3317	3265	3214	3164	3114	3065	3017	52
53	3583	3528	3474	3421	3368	3316	3265	3214	3163	3114	3065	3016	53
54	3582	3527	3473	3420	3367	3315	3264	3213	3163	3113	3064	3015	54
55	3581	3526	3472	3419	3366	3314	3263	3212	3162	3112	3063	3014	55
56	3580	3525	3471	3418	3365	3313	3262	3211	3161	3111	3062	3014	56
57	3579	3525	3471	3417	3365	3313	3261	3210	3160	3110	3061	3013	57
58	3578	3524	3470	3416	3364	3312	3260	3209	3159	3110	3060	3012	58
59	3577	3523	3469	3415	3363	3311	3259	3209	3158	3109	3060	3011	59
S.	1° 18′	1° 19′	1° 20′	1° 21′	1° 22′	1° 23′	1° 24′	1° 25′	1° 26′	1° 27′	1° 28′	1° 29′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 1° 30′	h m 1° 31′	h m 1° 32′	h m 1° 33′	h m 1° 34′	h m 1° 35′	h m 1° 36′	h m 1° 37′	h m 1° 38′	h m 1° 39′	h m 1° 40′	h m 1° 41′	S.
0	3010	2962	2915	2868	2821	2775	2730	2685	2640	2596	2553	2510	0
1	3009	2962	2914	2867	2821	2775	2729	2684	2640	2596	2552	2509	1
2	3009	2961	2913	2866	2820	2774	2729	2684	2639	2595	2551	2508	2
3	3008	2960	2912	2866	2819	2773	2728	2683	2638	2594	2551	2507	3
4	3007	2959	2912	2865	2818	2772	2727	2682	2638	2593	2550	2507	4
5	3006	2958	2911	2864	2818	2772	2726	2681	2637	2593	2549	2506	5
6	3005	2958	2910	2863	2817	2771	2725	2681	2636	2592	2548	2505	6
7	3005	2957	2909	2862	2816	2770	2725	2680	2635	2591	2548	2504	7
8	3004	2956	2909	2862	2815	2769	2724	2679	2635	2591	2547	2504	8
9	3003	2955	2908	2861	2815	2769	2723	2678	2634	2590	2546	2503	9
10	3002	2954	2907	2860	2814	2768	2722	2678	2633	2589	2545	2502	10
11	3001	2954	2906	2859	2813	2767	2722	2677	2632	2588	2545	2502	11
12	3001	2953	2905	2859	2812	2766	2721	2676	2632	2588	2544	2501	12
13	3000	2952	2905	2858	2811	2766	2720	2675	2631	2587	2543	2500	13
14	2999	2951	2904	2857	2811	2765	2719	2675	2630	2586	2543	2499	14
15	2998	2950	2903	2856	2810	2764	2719	2674	2629	2585	2542	2499	15
16	2997	2950	2902	2855	2809	2763	2718	2673	2629	2585	2541	2498	16
17	2997	2949	2901	2855	2808	2763	2717	2672	2628	2584	2540	2497	17
18	2996	2948	2901	2854	2808	2762	2716	2672	2627	2583	2540	2497	18
19	2995	2947	2900	2853	2807	2761	2716	2671	2626	2583	2539	2496	19
20	2994	2946	2899	2852	2806	2760	2715	2670	2626	2582	2538	2495	20
21	2993	2946	2898	2852	2805	2760	2714	2669	2625	2581	2538	2494	21
22	2993	2945	2898	2851	2805	2759	2713	2669	2624	2580	2537	2494	22
23	2992	2944	2897	2850	2804	2758	2713	2668	2624	2580	2536	2493	23
24	2991	2943	2896	2849	2803	2757	2712	2667	2623	2579	2535	2492	24
25	2990	2942	2895	2848	2802	2756	2711	2666	2622	2578	2535	2492	25
26	2989	2942	2894	2848	2801	2756	2710	2666	2621	2577	2534	2491	26
27	2989	2941	2894	2847	2801	2755	2710	2665	2621	2577	2533	2490	27
28	2988	2940	2893	2846	2800	2754	2709	2664	2620	2576	2533	2489	28
29	2987	2939	2892	2845	2799	2753	2708	2663	2619	2575	2532	2489	29
30	2986	2939	2891	2845	2798	2753	2707	2663	2618	2574	2531	2488	30
31	2985	2938	2891	2844	2798	2752	2707	2662	2618	2574	2530	2487	31
32	2985	2937	2890	2843	2797	2751	2706	2661	2617	2573	2530	2487	32
33	2984	2936	2889	2842	2796	2750	2705	2660	2616	2572	2529	2486	33
34	2983	2935	2888	2842	2795	2750	2704	2660	2615	2572	2528	2485	34
35	2982	2935	2887	2841	2795	2749	2704	2659	2615	2571	2527	2485	35
36	2981	2934	2887	2840	2794	2748	2703	2658	2614	2570	2527	2484	36
37	2981	2933	2886	2839	2793	2747	2702	2657	2613	2569	2526	2483	37
38	2980	2932	2885	2838	2792	2747	2701	2657	2612	2569	2525	2482	38
39	2979	2931	2884	2838	2792	2746	2701	2656	2612	2568	2525	2482	39
40	2978	2931	2883	2837	2791	2745	2700	2655	2611	2567	2524	2481	40
41	2977	2930	2883	2836	2790	2744	2699	2655	2610	2566	2523	2480	41
42	2977	2929	2882	2835	2789	2744	2698	2654	2610	2566	2522	2480	42
43	2976	2928	2881	2835	2788	2743	2698	2653	2609	2565	2522	2479	43
44	2975	2927	2880	2834	2788	2742	2697	2652	2608	2564	2521	2478	44
45	2974	2927	2880	2833	2787	2741	2696	2652	2607	2564	2520	2477	45
46	2973	2926	2879	2832	2786	2741	2695	2651	2607	2563	2520	2477	46
47	2973	2925	2878	2831	2785	2740	2695	2650	2606	2562	2519	2476	47
48	2972	2924	2877	2831	2785	2739	2694	2649	2605	2561	2518	2475	48
49	2971	2924	2876	2830	2784	2738	2693	2649	2604	2561	2517	2475	49
50	2970	2923	2876	2829	2783	2738	2692	2648	2604	2560	2517	2474	50
51	2969	2922	2875	2828	2782	2737	2692	2647	2603	2559	2516	2473	51
52	2969	2921	2874	2828	2782	2736	2691	2646	2602	2559	2515	2472	52
53	2968	2920	2873	2827	2781	2735	2690	2646	2601	2558	2515	2472	53
54	2967	2920	2873	2826	2780	2735	2689	2645	2601	2557	2514	2471	54
55	2966	2919	2872	2825	2779	2734	2689	2644	2600	2556	2513	2470	55
56	2965	2918	2871	2825	2779	2733	2688	2643	2599	2556	2512	2470	56
57	2965	2917	2870	2824	2778	2732	2687	2643	2599	2555	2512	2469	57
58	2964	2916	2869	2823	2777	2732	2687	2642	2598	2554	2511	2468	58
59	2963	2916	2869	2822	2776	2731	2686	2641	2597	2553	2510	2467	59
S.	1° 30′	1° 31′	1° 32′	1° 33′	1° 34′	1° 35′	1° 36′	1° 37′	1° 38′	1° 39′	1° 40′	1° 41′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 1° 42′	h m 1° 43′	h m 1° 44′	h m 1° 45′	h m 1° 46′	h m 1° 47′	h m 1° 48′	h m 1° 49′	h m 1° 50′	h m 1° 51′	h m 1° 52′	h m 1° 53′	S.
0	2467	2424	2382	2341	2300	2259	2218	2178	2139	2099	2061	2022	0
1	2466	2424	2382	2340	2299	2258	2218	2178	2138	2099	2060	2021	1
2	2465	2423	2381	2339	2298	2258	2217	2177	2137	2098	2059	2021	2
3	2465	2422	2380	2339	2298	2257	2216	2176	2137	2098	2059	2020	3
4	2464	2422	2380	2338	2297	2256	2216	2176	2136	2097	2058	2019	4
5	2463	2421	2379	2337	2296	2256	2215	2175	2136	2096	2057	2019	5
6	2462	2420	2378	2337	2296	2255	2214	2174	2135	2096	2057	2018	6
7	2462	2419	2378	2336	2295	2254	2214	2174	2134	2095	2056	2017	7
8	2461	2419	2377	2335	2294	2253	2213	2173	2134	2094	2055	2017	8
9	2460	2418	2376	2335	2293	2253	2212	2172	2133	2094	2055	2016	9
10	2460	2417	2375	2334	2293	2252	2212	2172	2132	2093	2054	2016	10
11	2459	2417	2375	2333	2292	2251	2211	2171	2132	2092	2053	2015	11
12	2458	2416	2374	2333	2291	2251	2210	2170	2131	2092	2053	2014	12
13	2458	2415	2373	2332	2291	2250	2210	2170	2130	2091	2052	2014	13
14	2457	2415	2373	2331	2290	2249	2209	2169	2130	2090	2052	2013	14
15	2456	2414	2372	2331	2289	2249	2208	2169	2129	2090	2051	2012	15
16	2455	2413	2371	2330	2289	2248	2208	2168	2128	2089	2050	2012	16
17	2455	2412	2371	2329	2288	2247	2207	2167	2128	2088	2050	2011	17
18	2454	2412	2370	2328	2287	2247	2206	2167	2127	2088	2049	2010	18
19	2453	2411	2369	2328	2287	2246	2206	2166	2126	2087	2048	2010	19
20	2453	2410	2368	2327	2286	2245	2205	2165	2126	2086	2048	2009	20
21	2452	2410	2368	2326	2285	2245	2204	2165	2125	2086	2047	2009	21
22	2451	2409	2367	2326	2285	2244	2204	2164	2124	2085	2046	2008	22
23	2450	2408	2366	2325	2284	2243	2203	2163	2124	2085	2046	2007	23
24	2450	2408	2366	2324	2283	2243	2202	2163	2123	2084	2045	2007	24
25	2449	2407	2365	2324	2283	2242	2202	2162	2122	2033	2044	2006	25
26	2448	2406	2364	2323	2282	2241	2201	2161	2122	2083	2044	2005	26
27	2448	2405	2364	2322	2281	2241	2200	2161	2121	2082	2043	2005	27
28	2447	2405	2363	2322	2281	2240	2200	2160	2120	2081	2042	2004	28
29	2446	2404	2362	2321	2280	2239	2199	2159	2120	2081	2042	2003	29
30	2445	2403	2362	2320	2279	2239	2198	2159	2119	2030	2041	2003	30
31	2445	2403	2361	2320	2279	2238	2198	2158	2118	2079	2041	2002	31
32	2444	2402	2360	2319	2278	2237	2197	2157	2118	2079	2040	2001	32
33	2443	2401	2359	2318	2277	2237	2196	2157	2117	2078	2039	2001	33
34	2443	2401	2359	2317	2277	2236	2196	2156	2116	2077	2039	2000	34
35	2442	2400	2358	2317	2276	2235	2195	2155	2116	2077	2038	2000	35
36	2441	2399	2357	2316	2275	2235	2194	2155	2115	2076	2037	1999	36
37	2441	2398	2357	2315	2274	2234	2194	2154	2115	2075	2037	1998	37
38	2440	2398	2356	2315	2274	2233	2193	2153	2114	2075	2036	1998	38
39	2439	2397	2355	2314	2273	2233	2192	2153	2113	2074	2035	1997	39
40	2438	2396	2355	2313	2272	2232	2192	2152	2113	2073	2035	1996	40
41	2438	2396	2354	2313	2272	2231	2191	2151	2112	2073	2034	1996	41
42	2437	2395	2353	2312	2271	2231	2190	2151	2111	2072	2033	1995	42
43	2436	2394	2353	2311	2270	2230	2190	2150	2111	2072	2033	1994	43
44	2436	2394	2352	2311	2270	2229	2189	2149	2110	2071	2032	1994	44
45	2435	2393	2351	2310	2269	2229	2188	2149	2109	2070	2032	1993	45
46	2434	2392	2350	2309	2268	2228	2188	2148	2109	2070	2031	1993	46
47	2433	2391	2350	2309	2268	2227	2187	2147	2108	2069	2030	1992	47
48	2433	2391	2349	2308	2267	2227	2186	2147	2107	2068	2030	1991	48
49	2432	2390	2348	2307	2266	2226	2186	2146	2107	2068	2029	1991	49
50	2431	2339	2348	2307	2266	2225	2185	2145	2106	2067	2028	1990	50
51	2431	2389	2347	2306	2265	2225	2184	2145	2105	2066	2028	1989	51
52	2430	2388	2346	2305	2264	2224	2184	2144	2105	2066	2027	1989	52
53	2429	2387	2346	2304	2264	2223	2183	2143	2104	2065	2026	1988	53
54	2429	2387	2345	2304	2263	2223	2182	2143	2103	2064	2026	1987	54
55	2428	2386	2344	2303	2262	2222	2182	2142	2103	2064	2025	1987	55
56	2427	2385	2344	2302	2262	2221	2181	2141	2102	2063	2025	1986	56
57	2426	2384	2343	2302	2261	2220	2180	2141	2101	2062	2024	1986	57
58	2426	2384	2342	2301	2260	2220	2180	2140	2101	2062	2023	1985	58
59	2425	2383	2342	2300	2260	2219	2179	2139	2100	2061	2023	1984	59
S.	1° 42′	1° 43′	1° 44′	1° 45′	1° 46′	1° 47′	1° 48′	1° 49′	1° 50′	1° 51′	1° 52′	1° 53′	S.

PROPORTIONAL LOGARITHMS.

S.	h m 1° 54′	h m 1° 55′	h m 1° 56′	h m 1° 57′	h m 1° 58′	h m 1° 59′	h m 2° 0′	h m 2° 1′	h m 2° 2′	h m 2° 3′	h m 2° 4′	S.
0	1984	1946	1908	1871	1834	1797	1761	1725	1689	1654	1619	0
1	1983	1945	1908	1870	1833	1797	1760	1724	1689	1653	1618	1
2	1982	1944	1907	1870	1833	1796	1760	1724	1688	1652	1617	2
3	1982	1944	1906	1869	1832	1795	1759	1723	1687	1652	1617	3
4	1981	1943	1906	1868	1831	1795	1759	1722	1687	1651	1616	4
5	1981	1943	1905	1868	1831	1794	1758	1722	1686	1651	1616	5
6	1980	1942	1904	1867	1830	1794	1757	1721	1686	1650	1615	6
7	1979	1941	1904	1867	1830	1793	1757	1721	1685	1650	1614	7
8	1979	1941	1903	1866	1829	1792	1756	1720	1684	1649	1614	8
9	1978	1940	1903	1865	1828	1792	1755	1719	1684	1648	1613	9
10	1977	1939	1902	1865	1828	1791	1755	1719	1683	1648	1613	10
11	1977	1939	1901	1864	1827	1791	1754	1718	1683	1647	1612	11
12	1976	1938	1901	1863	1827	1790	1754	1718	1682	1647	1612	12
13	1975	1938	1900	1863	1826	1789	1753	1717	1681	1646	1611	13
14	1975	1937	1899	1862	1825	1789	1752	1717	1681	1645	1610	14
15	1974	1936	1899	1862	1825	1788	1752	1716	1680	1645	1610	15
16	1974	1936	1898	1861	1824	1788	1751	1715	1680	1644	1609	16
17	1973	1935	1898	1860	1823	1787	1751	1715	1679	1644	1609	17
18	1972	1934	1897	1860	1823	1786	1750	1714	1678	1643	1608	18
19	1972	1934	1896	1859	1822	1786	1749	1714	1678	1643	1607	19
20	1971	1933	1896	1859	1822	1785	1749	1713	1677	1642	1607	20
21	1970	1933	1895	1858	1821	1785	1748	1712	1677	1641	1606	21
22	1970	1932	1894	1857	1820	1784	1748	1712	1676	1641	1606	22
23	1969	1931	1894	1857	1820	1783	1747	1711	1676	1640	1605	23
24	1968	1931	1893	1856	1819	1783	1746	1711	1675	1640	1605	24
25	1968	1930	1893	1855	1819	1782	1746	1710	1674	1639	1604	25
26	1967	1929	1892	1855	1818	1781	1745	1709	1674	1638	1603	26
27	1967	1929	1891	1854	1817	1781	1745	1709	1673	1638	1603	27
28	1966	1928	1891	1854	1817	1780	1744	1708	1673	1637	1602	28
29	1965	1928	1890	1853	1816	1780	1743	1708	1672	1637	1602	29
30	1965	1927	1889	1852	1816	1779	1743	1707	1671	1636	1601	30
31	1964	1926	1889	1852	1815	1778	1742	1706	1671	1635	1600	31
32	1963	1926	1888	1851	1814	1778	1742	1706	1670	1635	1600	32
33	1963	1925	1888	1850	1814	1777	1741	1705	1670	1634	1599	33
34	1962	1924	1887	1850	1813	1777	1740	1705	1669	1634	1599	34
35	1962	1924	1886	1849	1812	1776	1740	1704	1668	1633	1598	35
36	1961	1923	1886	1849	1812	1775	1739	1703	1668	1633	1598	36
37	1960	1923	1885	1848	1811	1775	1739	1703	1667	1632	1597	37
38	1960	1922	1884	1847	1811	1774	1738	1702	1667	1631	1596	38
39	1959	1921	1884	1847	1810	1774	1737	1702	1666	1631	1596	39
40	1958	1921	1883	1846	1809	1773	1737	1701	1665	1630	1595	40
41	1958	1920	1883	1846	1809	1772	1736	1700	1665	1630	1595	41
42	1957	1919	1882	1845	1808	1772	1736	1700	1664	1629	1594	42
43	1956	1919	1881	1844	1808	1771	1735	1699	1664	1628	1593	43
44	1956	1918	1881	1844	1807	1771	1734	1699	1663	1628	1593	44
45	1955	1918	1880	1843	1806	1770	1734	1698	1663	1627	1592	45
46	1955	1917	1880	1843	1806	1769	1733	1697	1662	1627	1592	46
47	1954	1916	1879	1842	1805	1769	1733	1697	1661	1626	1591	47
48	1953	1916	1878	1841	1805	1768	1732	1696	1661	1626	1591	48
49	1953	1915	1878	1841	1804	1768	1731	1696	1660	1625	1590	49
50	1952	1914	1877	1840	1803	1767	1731	1695	1660	1624	1589	50
51	1951	1914	1876	1839	1803	1766	1730	1694	1659	1624	1589	51
52	1951	1913	1876	1839	1802	1766	1730	1694	1658	1623	1588	52
53	1950	1913	1875	1838	1802	1765	1729	1693	1658	1623	1588	53
54	1950	1912	1875	1838	1801	1765	1728	1693	1657	1622	1587	54
55	1949	1911	1874	1837	1800	1764	1728	1692	1657	1621	1587	55
56	1948	1911	1873	1836	1800	1763	1727	1692	1656	1621	1586	56
57	1948	1910	1873	1836	1799	1763	1727	1691	1655	1620	1585	57
58	1947	1909	1872	1835	1798	1762	1726	1690	1655	1620	1585	58
59	1946	1909	1871	1835	1798	1762	1725	1690	1654	1619	1584	59
S.	1° 54′	1° 55′	1° 56′	1° 57′	1° 58′	1° 59′	2° 0′	2° 1′	2° 2′	2° 3′	2° 4′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 2° 5′	h m 2° 6′	h m 2° 7′	h m 2° 8′	h m 2° 9′	h m 2° 10′	h m 2° 11′	h m 2° 12′	h m 2° 13′	h m 2° 14′	h m 2° 15′	S.
0	1584	1549	1515	1481	1447	1413	1380	1347	1314	1282	1249	0
1	1583	1548	1514	1480	1446	1413	1379	1346	1314	1281	1249	1
2	1582	1548	1514	1479	1446	1412	1379	1346	1313	1281	1248	2
3	1582	1547	1513	1479	1445	1412	1378	1345	1313	1280	1248	3
4	1581	1547	1512	1478	1445	1411	1378	1345	1312	1280	1247	4
5	1581	1546	1512	1478	1444	1411	1377	1344	1311	1279	1247	5
6	1580	1546	1511	1477	1443	1410	1377	1344	1311	1278	1246	6
7	1580	1545	1511	1477	1443	1409	1376	1343	1310	1278	1246	7
8	1579	1544	1510	1476	1442	1409	1376	1343	1310	1277	1245	8
9	1578	1544	1510	1476	1442	1408	1375	1342	1309	1277	1245	9
10	1578	1543	1509	1475	1441	1408	1374	1342	1309	1276	1244	10
11	1577	1543	1508	1474	1441	1407	1374	1341	1308	1276	1243	11
12	1577	1542	1508	1474	1440	1407	1373	1340	1308	1275	1243	12
13	1576	1542	1507	1473	1440	1406	1373	1340	1307	1275	1242	13
14	1576	1541	1507	1473	1439	1406	1372	1339	1307	1274	1242	14
15	1575	1540	1506	1472	1438	1405	1372	1339	1306	1274	1241	15
16	1574	1540	1506	1472	1438	1404	1371	1338	1306	1273	1241	16
17	1574	1539	1505	1471	1437	1404	1371	1338	1305	1273	1240	17
18	1573	1539	1504	1470	1437	1403	1370	1337	1304	1272	1240	18
19	1573	1538	1504	1470	1436	1403	1370	1337	1304	1271	1239	19
20	1572	1538	1503	1469	1436	1402	1369	1336	1303	1271	1239	20
21	1571	1537	1503	1469	1435	1402	1368	1335	1303	1270	1238	21
22	1571	1536	1502	1468	1435	1401	1368	1335	1302	1270	1238	22
23	1570	1536	1502	1468	1434	1401	1367	1334	1302	1269	1237	23
24	1570	1535	1501	1467	1433	1400	1367	1334	1301	1269	1237	24
25	1569	1535	1500	1467	1433	1399	1366	1333	1301	1268	1236	25
26	1569	1534	1500	1466	1432	1399	1366	1333	1300	1268	1235	26
27	1568	1534	1499	1465	1432	1398	1365	1332	1300	1267	1235	27
28	1567	1533	1499	1465	1431	1398	1365	1332	1299	1267	1234	28
29	1567	1532	1498	1464	1431	1397	1364	1331	1298	1266	1234	29
30	1566	1532	1498	1464	1430	1397	1363	1331	1298	1266	1233	30
31	1566	1531	1497	1463	1429	1396	1363	1330	1297	1265	1233	31
32	1565	1531	1496	1463	1429	1396	1362	1329	1297	1264	1232	32
33	1565	1530	1496	1462	1428	1395	1362	1329	1296	1264	1232	33
34	1564	1530	1495	1461	1428	1394	1361	1328	1296	1263	1231	34
35	1563	1529	1495	1461	1427	1394	1361	1328	1295	1263	1231	35
36	1563	1528	1494	1460	1427	1393	1360	1327	1295	1262	1230	36
37	1562	1528	1494	1460	1426	1393	1360	1327	1294	1262	1230	37
38	1562	1527	1493	1459	1426	1392	1359	1326	1294	1261	1229	38
39	1561	1527	1493	1459	1425	1392	1359	1326	1293	1261	1229	39
40	1561	1526	1492	1458	1424	1391	1358	1325	1292	1260	1228	40
41	1560	1526	1491	1458	1424	1391	1357	1325	1292	1260	1227	41
42	1559	1525	1491	1457	1423	1390	1357	1324	1291	1259	1227	42
43	1559	1524	1490	1456	1423	1389	1356	1323	1291	1259	1226	43
44	1558	1524	1490	1456	1422	1389	1356	1323	1290	1258	1226	44
45	1558	1523	1489	1455	1422	1388	1355	1322	1290	1257	1225	45
46	1557	1523	1489	1455	1421	1388	1355	1322	1289	1257	1225	46
47	1556	1522	1488	1454	1421	1387	1354	1321	1289	1256	1224	47
48	1556	1522	1487	1454	1420	1387	1354	1321	1288	1256	1224	48
49	1555	1521	1487	1453	1419	1386	1353	1320	1288	1255	1223	49
50	1555	1520	1486	1452	1419	1386	1352	1320	1287	1255	1223	50
51	1554	1520	1486	1452	1418	1385	1352	1319	1287	1254	1222	51
52	1554	1519	1485	1451	1418	1384	1351	1319	1286	1254	1222	52
53	1553	1519	1485	1451	1417	1384	1351	1318	1285	1253	1221	53
54	1552	1518	1484	1450	1417	1383	1350	1317	1285	1253	1221	54
55	1552	1518	1483	1450	1416	1383	1350	1317	1284	1252	1220	55
56	1551	1517	1483	1449	1416	1382	1349	1316	1284	1252	1219	56
57	1551	1516	1482	1449	1415	1382	1349	1316	1283	1251	1219	57
58	1550	1516	1482	1448	1414	1381	1348	1315	1283	1250	1218	58
59	1550	1515	1481	1447	1414	1381	1348	1315	1282	1250	1218	59
S.	2° 5′	2° 6′	2° 7′	2° 8′	2° 9′	2° 10′	2° 11′	2° 12′	2° 13′	2° 14′	2° 15′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 2° 16′	h m 2° 17′	h m 2° 18′	h m 2° 19′	h m 2° 20′	h m 2° 21′	h m 2° 22′	h m 2° 23′	h m 2° 24′	h m 2° 25′	h m 2° 26′	S.
0	1217	1186	1154	1123	1091	1061	1030	0999	0969	0939	0909	0
1	1217	1185	1153	1122	1091	1060	1029	0999	0969	0939	0909	1
2	1216	1184	1153	1122	1090	1060	1029	0998	0968	0938	0908	2
3	1216	1184	1152	1121	1090	1059	1028	0998	0968	0938	0908	3
4	1215	1183	1152	1120	1089	1058	1028	0997	0967	0937	0907	4
5	1215	1183	1151	1120	1089	1058	1027	0997	0967	0937	0907	5
6	1214	1182	1151	1119	1088	1057	1027	0996	0966	0936	0906	6
7	1214	1182	1150	1119	1088	1057	1026	0996	0966	0936	0906	7
8	1213	1181	1150	1118	1087	1056	1026	0995	0965	0935	0905	8.
9	1213	1181	1149	1118	1087	1056	1025	0995	0965	0935	0905	9
10	1212	1180	1149	1117	1086	1055	1025	0994	0964	0934	0904	10
11	1211	1180	1148	1117	1086	1055	1024	0994	0964	0934	0904	11
12	1211	1179	1148	1116	1085	1054	1024	0993	0963	0933	0903	12
13	1210	1179	1147	1116	1085	1054	1023	0993	0963	0933	0903	13
14	1210	1178	1147	1115	1084	1053	1023	0992	0962	0932	0902	14
15	1209	1178	1146	1115	1084	1053	1022	0992	0962	0932	0902	15
16	1209	1177	1146	1114	1083	1052	1022	0991	0961	0931	0901	16
17	1208	1177	1145	1114	1083	1052	1021	0991	0961	0931	0901	17
18	1208	1176	1145	1113	1082	1051	1021	0990	0960	0930	0900	18
19	1207	1175	1144	1113	1082	1051	1020	0990	0960	0930	0900	19
20	1207	1175	1143	1112	1081	1050	1020	0989	0959	0929	0899	20
21	1206	1174	1143	1112	1081	1050	1019	0989	0959	0929	0899	21
22	1206	1174	1142	1111	1080	1049	1019	0988	0958	0928	0898	22
23	1205	1173	1142	1111	1080	1049	1018	0988	0958	0928	0898	23
24	1205	1173	1141	1110	1079	1048	1018	0987	0957	0927	0897	24
25	1204	1172	1141	1110	1079	1048	1017	0987	0957	0927	0897	25
26	1204	1172	1140	1109	1078	1047	1017	0986	0956	0926	0896	26
27	1203	1171	1140	1109	1078	1047	1016	0986	0956	0926	0896	27
28	1202	1171	1139	1108	1077	1046	1016	0985	0955	0925	0895	28
29	1202	1170	1139	1108	1076	1046	1015	0985	0955	0925	0895	29
30	1201	1170	1138	1107	1076	1045	1015	0984	0954	0924	0894	30
31	1201	1169	1138	1106	1075	1045	1014	0984	0954	0924	0894	31
32	1200	1169	1137	1106	1075	1044	1014	0983	0953	0923	0893	32
33	1200	1168	1137	1105	1074	1044	1013	0983	0953	0923	0893	33
34	1199	1168	1136	1105	1074	1043	1013	0982	0952	0922	0892	34
35	1199	1167	1136	1104	1073	1043	1012	0982	0952	0922	0892	35
36	1198	1167	1135	1104	1073	1042	1012	0981	0951	0921	0891	36
37	1198	1166	1135	1103	1072	1042	1011	0981	0951	0921	0891	37
38	1197	1165	1134	1103	1072	1041	1011	0980	0950	0920	0890	38
39	1197	1165	1134	1102	1071	1041	1010	0980	0950	0920	0890	39
40	1196	1164	1133	1102	1071	1040	1009	0979	0949	0919	0889	40
41	1196	1164	1132	1101	1070	1040	1009	0979	0949	0919	0889	41
42	1195	1163	1132	1101	1070	1039	1008	0978	0948	0918	0888	42
43	1195	1163	1131	1100	1069	1039	1008	0978	0948	0918	0888	43
44	1194	1162	1131	1100	1069	1038	1007	0977	0947	0917	0887	44
45	1193	1162	1130	1099	1068	1037	1007	0977	0947	0917	0887	45
46	1193	1161	1130	1099	1068	1037	1006	0976	0946	0916	0886	46
47	1192	1161	1129	1098	1067	1036	1006	0976	0946	0916	0886	47
48	1192	1160	1129	1098	1067	1036	1005	0975	0945	0915	0885	48
49	1191	1160	1128	1097	1066	1035	1005	0975	0945	0915	0885	49
50	1191	1159	1128	1097	1066	1035	1004	0974	0944	0914	0884	50
51	1190	1159	1127	1096	1065	1034	1004	0974	0944	0914	0884	51
52	1190	1158	1127	1096	1065	1034	1003	0973	0943	0913	0883	52
53	1189	1158	1126	1095	1064	1033	1003	0973	0943	0913	0883	53
54	1189	1157	1126	1095	1064	1033	1002	0972	0942	0912	0883	54
55	1188	1157	1125	1094	1063	1032	1002	0972	0942	0912	0882	55
56	1188	1156	1125	1094	1063	1032	1001	0971	0941	0911	0882	56
57	1187	1156	1124	1093	1062	1031	1001	0971	0941	0911	0881	57
58	1187	1155	1124	1092	1062	1031	1000	0970	0940	0910	0881	58
59	1186	1154	1123	1092	1061	1030	1000	0970	0940	0910	0880	59
S.	2° 16′	2° 17′	2° 18′	2° 19′	2° 20′	2° 21′	2° 22′	2° 23′	2° 24′	2° 25′	2° 26′	S

PROPORTIONAL LOGARITHMS.

S.	h m 2° 27′	h m 2° 28′	h m 2° 29′	h m 2° 30′	h m 2° 31′	h m 2° 32′	h m 2° 33′	h m 2° 34′	h m 2° 35′	h m 2° 36′	h m 2° 37′	S.
0	0880	0850	0821	0792	0763	0734	0706	0678	0649	0621	0594	0
1	0879	0850	0820	0791	0762	0734	0705	0677	0649	0621	0593	1
2	0879	0849	0820	0791	0762	0733	0705	0677	0648	0621	0593	2
3	0878	0849	0819	0790	0762	0733	0704	0676	0648	0620	0592	3
4	0878	0848	0819	0790	0761	0732	0704	0676	0648	0620	0592	4
5	0877	0848	0818	0789	0761	0732	0703	0675	0647	0619	0591	5
6	0877	0847	0818	0789	0760	0731	0703	0675	0647	0619	0591	6
7	0876	0847	0817	0788	0760	0731	0703	0674	0646	0618	0591	7
8	0876	0846	0817	0788	0759	0730	0702	0674	0646	0618	0590	8
9	0875	0846	0816	0787	0759	0730	0702	0673	0645	0617	0590	9
10	0875	0845	0816	0787	0758	0730	0701	0673	0645	0617	0589	10
11	0874	0845	0816	0787	0758	0729	0701	0672	0644	0616	0589	11
12	0874	0844	0815	0786	0757	0729	0700	0672	0644	0616	0588	12
13	0873	0844	0815	0786	0757	0728	0700	0671	0643	0615	0588	13
14	0873	0843	0814	0785	0756	0728	0699	0671	0643	0615	0587	14
15	0872	0843	0814	0785	0756	0727	0699	0670	0642	0615	0587	15
16	0872	0842	0813	0784	0755	0727	0698	0670	0642	0614	0586	16
17	0871	0842	0813	0784	0755	0726	0698	0670	0641	0614	0586	17
18	0871	0841	0812	0783	0754	0726	0697	0669	0641	0613	0585	18
19	0870	0841	0812	0783	0754	0725	0697	0669	0641	0613	0585	19
20	0870	0840	0811	0782	0753	0725	0696	0668	0640	0612	0585	20
21	0869	0840	0811	0782	0753	0724	0696	0668	0640	0612	0584	21
22	0869	0839	0810	0781	0752	0724	0695	0667	0639	0611	0584	22
23	0868	0839	0810	0781	0752	0723	0695	0667	0639	0611	0583	23
24	0868	0838	0809	0780	0751	0723	0694	0666	0638	0610	0583	24
25	0867	0838	0809	0780	0751	0722	0694	0666	0638	0610	0582	25
26	0867	0837	0808	0779	0751	0722	0694	0665	0637	0609	0582	26
27	0866	0837	0808	0779	0750	0721	0693	0665	0637	0609	0581	27
28	0866	0836	0807	0778	0750	0721	0693	0664	0636	0609	0581	28
29	0865	0836	0807	0778	0749	0721	0692	0664	0636	0608	0580	29
30	0865	0835	0806	0777	0749	0720	0692	0663	0635	0608	0580	30
31	0864	0835	0806	0777	0748	0720	0691	0663	0635	0607	0579	31
32	0864	0834	0805	0776	0748	0719	0691	0663	0634	0607	0579	32
33	0863	0834	0805	0776	0747	0719	0690	0662	0634	0606	0579	33
34	0863	0834	0804	0775	0747	0718	0690	0662	0634	0606	0578	34
35	0862	0833	0804	0775	0746	0718	0689	0661	0633	0605	0578	35
36	0862	0833	0803	0774	0746	0717	0689	0661	0633	0605	0577	36
37	0861	0832	0803	0774	0745	0717	0688	0660	0632	0604	0577	37
38	0861	0832	0802	0774	0745	0716	0688	0660	0632	0604	0576	38
39	0860	0831	0802	0773	0744	0716	0687	0659	0631	0603	0576	39
40	0860	0831	0801	0773	0744	0715	0687	0659	0631	0603	0575	40
41	0859	0830	0801	0772	0743	0715	0686	0658	0630	0602	0575	41
42	0859	0830	0801	0772	0743	0714	0686	0658	0630	0602	0574	42
43	0858	0829	0800	0771	0742	0714	0686	0657	0629	0602	0574	43
44	0858	0829	0800	0771	0742	0713	0685	0657	0629	0601	0573	44
45	0857	0828	0799	0770	0741	0713	0685	0656	0628	0601	0573	45
46	0857	0828	0799	0770	0741	0712	0684	0656	0628	0600	0573	46
47	0856	0827	0798	0769	0740	0712	0684	0655	0628	0600	0572	47
48	0856	0827	0798	0769	0740	0711	0683	0655	0627	0599	0572	48
49	0855	0826	0797	0768	0740	0711	0683	0655	0627	0599	0571	49
50	0855	0826	0797	0768	0739	0711	0682	0654	0626	0598	0571	50
51	0855	0825	0796	0767	0739	0710	0682	0654	0626	0598	0570	51
52	0854	0825	0796	0767	0738	0710	0681	0653	0625	0597	0570	52
53	0854	0824	0795	0766	0738	0709	0681	0653	0625	0597	0569	53
54	0853	0824	0795	0766	0737	0709	0680	0652	0624	0596	0569	54
55	0853	0823	0794	0765	0737	0708	0680	0652	0624	0596	0568	55
56	0852	0823	0794	0765	0736	0708	0679	0651	0623	0596	0568	56
57	0852	0822	0793	0764	0736	0707	0679	0651	0623	0595	0568	57
58	0851	0822	0793	0764	0735	0707	0678	0650	0622	0595	0567	58
59	0851	0821	0792	0763	0735	0706	0678	0650	0622	0594	0567	59
S.	2° 27′	2° 28′	2° 29′	2° 30′	2° 31′	2° 32′	2° 33′	2° 34′	2° 35′	2° 36′	2° 37′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 2° 38′	h m 2° 39′	h m 2° 40′	h m 2° 41′	h m 2° 42′	h m 2° 43′	h m 2° 44′	h m 2° 45′	h m 2° 46′	h m 2° 47′	h m 2° 48′	S.
0	0566	0539	0512	0484	0458	0431	0404	0378	0352	0326	0300	0
1	0566	0538	0511	0484	0457	0430	0404	0377	0351	0325	0299	1
2	0565	0538	0511	0484	0457	0430	0403	0377	0351	0325	0299	2
3	0565	0537	0510	0483	0456	0430	0403	0377	0350	0324	0298	3
4	0564	0537	0510	0483	0456	0429	0403	0376	0350	0324	0298	4
5	0564	0536	0509	0482	0455	0429	0402	0376	0349	0323	0297	5
6	0563	0536	0509	0482	0455	0428	0402	0375	0349	0323	0297	6
7	0563	0536	0508	0481	0454	0428	0401	0375	0349	0323	0297	7
8	0562	0535	0508	0481	0454	0427	0401	0374	0348	0322	0296	8
9	0562	0535	0507	0480	0454	0427	0400	0374	0348	0322	0296	9
10	0562	0534	0507	0480	0453	0426	0400	0374	0347	0321	0295	10
11	0561	0534	0507	0480	0453	0426	0399	0373	0347	0321	0295	11
12	0561	0533	0506	0479	0452	0426	0399	0373	0346	0320	0294	12
13	0560	0533	0506	0479	0452	0425	0399	0372	0346	0320	0294	13
14	0560	0532	0505	0478	0451	0425	0398	0372	0346	0319	0294	14
15	0559	0532	0505	0478	0451	0424	0398	0371	0345	0319	0293	15
16	0559	0531	0504	0477	0450	0424	0397	0371	0345	0319	0293	16
17	0558	0531	0504	0477	0450	0423	0397	0370	0344	0318	0292	17
18	0558	0531	0503	0476	0450	0423	0396	0370	0344	0318	0292	18
19	0557	0530	0503	0476	0449	0422	0396	0370	0343	0317	0291	19
20	0557	0530	0502	0475	0449	0422	0395	0369	0343	0317	0291	20
21	0557	0529	0502	0475	0448	0422	0395	0369	0342	0316	0291	21
22	0556	0529	0502	0475	0448	0421	0395	0368	0342	0316	0290	22
23	0556	0528	0501	0474	0447	0421	0394	0368	0342	0316	0290	23
24	0555	0528	0501	0474	0447	0420	0394	0367	0341	0315	0289	24
25	0555	0527	0500	0473	0446	0420	0393	0367	0341	0315	0289	25
26	0554	0527	0500	0473	0446	0419	0393	0366	0340	0314	0288	26
27	0554	0526	0499	0472	0446	0419	0392	0365	0340	0314	0288	27
23	0553	0526	0499	0472	0445	0418	0392	0366	0339	0313	0288	28
29	0553	0526	0498	0471	0445	0418	0392	0365	0339	0313	0287	29
30	0552	0525	0498	0471	0444	0418	0391	0365	0339	0313	0287	30
31	0552	0525	0498	0471	0444	0417	0391	0364	0338	0312	0286	31
32	0552	0524	0497	0470	0443	0417	0390	0364	0338	0312	0286	32
33	0551	0524	0497	0470	0443	0416	0390	0363	0337	0311	0285	33
34	0551	0523	0496	0469	0442	0416	0389	0363	0337	0311	0285	34
35	0550	0523	0496	0469	0442	0415	0389	0363	0336	0310	0285	35
36	0550	0522	0495	0468	0442	0415	0388	0362	0336	0310	0284	36
37	0549	0522	0495	0468	0441	0414	0388	0362	0336	0310	0284	37
38	0549	0521	0494	0467	0441	0414	0388	0361	0335	0309	0283	38
39	0548	0521	0494	0467	0440	0414	0387	0361	0335	0309	0283	39
40	0548	0521	0493	0467	0440	0413	0387	0360	0334	0308	0282	40
41	0547	0520	0493	0466	0439	0413	0386	0360	0334	0308	0282	41
42	0547	0520	0493	0466	0439	0412	0386	0359	0333	0307	0282	42
43	0546	0519	0492	0465	0438	0412	0385	0359	0333	0307	0281	43
44	0546	0519	0492	0465	0438	0411	0385	0359	0333	0307	0281	44
45	0546	0518	0491	0464	0438	0411	0384	0358	0332	0306	0280	45
46	0545	0518	0491	0464	0437	0410	0384	0358	0332	0306	0280	46
47	0545	0517	0490	0463	0437	0410	0384	0357	0331	0305	0279	47
48	0544	0517	0490	0463	0436	0410	0383	0357	0331	0305	0279	48
49	0544	0517	0489	0462	0436	0409	0383	0356	0330	0304	0279	49
50	0543	0516	0489	0462	0435	0409	0382	0356	0330	0304	0278	50
51	0543	0516	0489	0462	0435	0408	0382	0356	0329	0304	0278	51
52	0542	0515	0488	0461	0434	0408	0381	0355	0329	0303	0277	52
53	0542	0515	0488	0461	0434	0407	0381	0355	0329	0303	0277	53
54	0541	0514	0487	0460	0434	0407	0381	0354	0328	0302	0276	54
55	0541	0514	0487	0460	0433	0406	0380	0354	0328	0302	0276	55
56	0541	0513	0486	0459	0433	0406	0380	0353	0327	0301	0276	56
57	0540	0513	0486	0459	0432	0406	0379	0353	0327	0301	0275	57
58	0540	0512	0485	0458	0432	0405	0379	0353	0326	0300	0275	58
59	0539	0512	0485	0458	0431	0405	0378	0352	0326	0300	0274	59
S.	2° 38′	2° 39′	2° 40′	2° 41′	2° 42′	2° 43′	2° 44′	2° 45′	2° 46′	2° 47′	2° 48′	S.

TABLE XXII.

PROPORTIONAL LOGARITHMS.

S.	h m 2° 49′	h m 2° 50′	h m 2° 51′	h m 2° 52′	h m 2° 53′	h m 2° 54′	h m 2° 55′	h m 2° 56′	h m 2° 57′	h m 2° 58′	h m 2° 59′	S.
0	0274	0248	0223	0197	0172	0147	0122	0098	0073	0049	0024	0
1	0273	0248	0222	0197	0172	0147	0122	0097	0073	0048	0024	1
2	0273	0247	0222	0197	0171	0146	0122	0097	0072	0048	0023	2
3	0273	0247	0221	0196	0171	0146	0121	0096	0072	0047	0023	3
4	0272	0247	0221	0196	0171	0146	0121	0096	0071	0047	0023	4
5	0272	0246	0221	0195	0170	0145	0120	0096	0071	0046	0022	5
6	0271	0246	0220	0195	0170	0145	0120	0095	0071	0046	0022	6
7	0271	0245	0220	0194	0169	0144	0119	0095	0070	0046	0021	7
8	0270	0245	0219	0194	0169	0144	0119	0094	0070	0045	0021	8
9	0270	0244	0219	0194	0169	0143	0119	0094	0069	0045	0021	9
10	0270	0244	0219	0193	0168	0143	0118	0093	0069	0044	0020	10
11	0269	0244	0218	0193	0168	0143	0118	0093	0068	0044	0020	11
12	0269	0243	0218	0192	0167	0142	0117	0093	0068	0044	0019	12
13	0268	0243	0217	0192	0167	0142	0117	0092	0068	0043	0019	13
14	0268	0242	0217	0192	0166	0141	0117	0092	0067	0043	0019	14
15	0267	0242	0216	0191	0166	0141	0116	0091	0067	0042	0018	15
16	0267	0241	0216	0191	0166	0141	0116	0091	0066	0042	0018	16
17	0267	0241	0216	0190	0165	0140	0115	0091	0066	0042	0017	17
18	0266	0241	0215	0190	0165	0140	0115	0090	0066	0041	0017	18
19	0266	0240	0215	0189	0164	0139	0114	0090	0065	0041	0017	19
20	0265	0240	0214	0189	0164	0139	0114	0089	0065	0040	0016	20
21	0265	0239	0214	0189	0163	0139	0114	0089	0064	0040	0016	21
22	0264	0239	0213	0188	0163	0138	0113	0089	0064	0040	0015	22
23	0264	0238	0213	0188	0163	0138	0113	0088	0064	0039	0015	23
24	0264	0238	0213	0187	0162	0137	0112	0088	0063	0039	0015	24
25	0263	0238	0212	0187	0162	0137	0112	0087	0063	0038	0014	25
26	0263	0237	0212	0187	0161	0136	0112	0087	0062	0038	0014	26
27	0262	0237	0211	0186	0161	0136	0111	0087	0062	0038	0013	27
28	0262	0236	0211	0186	0161	0136	0111	0086	0062	0037	0013	28
29	0261	0236	0211	0185	0160	0135	0110	0086	0061	0037	0012	29
30	0261	0235	0210	0185	0160	0135	0110	0085	0061	0036	0012	30
31	0261	0235	0210	0184	0159	0134	0110	0085	0060	0036	0012	31
32	0260	0235	0209	0184	0159	0134	0109	0084	0060	0036	0011	32
33	0260	0234	0209	0184	0158	0134	0109	0084	0060	0035	0011	33
34	0259	0234	0208	0183	0158	0133	0108	0084	0059	0035	0010	34
35	0259	0233	0208	0183	0158	0133	0108	0083	0059	0034	0010	35
36	0258	0233	0208	0182	0157	0132	0107	0083	0058	0034	0010	36
37	0258	0233	0207	0182	0157	0132	0107	0082	0058	0034	0009	37
38	0258	0232	0207	0181	0156	0131	0107	0082	0057	0033	0009	38
39	0257	0232	0206	0181	0156	0131	0106	0082	0057	0033	0008	39
40	0257	0231	0206	0181	0156	0131	0106	0081	0057	0032	0008	40
41	0256	0231	0205	0180	0155	0130	0105	0081	0056	0032	0008	41
42	0256	0230	0205	0180	0155	0130	0105	0080	0056	0031	0007	42
43	0255	0230	0205	0179	0154	0129	0105	0080	0055	0031	0007	43
44	0255	0230	0204	0179	0154	0129	0104	0080	0055	0031	0006	44
45	0255	0229	0204	0179	0153	0129	0104	0079	0055	0030	0006	45
46	0254	0229	0203	0178	0153	0128	0103	0079	0054	0030	0006	46
47	0254	0228	0203	0178	0153	0128	0103	0078	0054	0029	0005	47
48	0253	0228	0202	0177	0152	0127	0103	0078	0053	0029	0005	48
49	0253	0227	0202	0177	0152	0127	0102	0077	0053	0029	0004	49
50	0252	0227	0202	0176	0151	0126	0102	0077	0053	0028	0004	50
51	0252	0227	0201	0176	0151	0126	0101	0077	0052	0028	0004	51
52	0252	0226	0201	0176	0151	0126	0101	0076	0052	0027	0003	52
53	0251	0226	0200	0175	0150	0125	0100	0076	0051	0027	0003	53
54	0251	0225	0200	0175	0150	0125	0100	0075	0051	0027	0002	54
55	0250	0225	0200	0174	0149	0124	0100	0075	0051	0026	0002	55
56	0250	0224	0199	0174	0149	0124	0099	0075	0050	0026	0002	56
57	0250	0224	0199	0174	0148	0124	0099	0074	0050	0025	0001	57
58	0249	0224	0198	0173	0148	0123	0098	0074	0049	0025	0001	58
59	0249	0223	0198	0173	0148	0123	0098	0073	0049	0025	0000	59.
S.	2° 49′	2° 50′	2° 51′	2° 52′	2° 53′	2° 54′	2° 55′	2° 56′	2° 57′	2° 58′	2° 59′	S.

HALF ELAPSED TIME.

0 HOUR.

M	0″	10″	20″	30″	40″	50″
0	Infinite.					
0	3.	13833				
0	2.		33730	66121	53627	43936
1	2.36018	29324	23525	18409	13834	09695
2	2.05916	02440				
2	1.		99221	96225	93422	90790
3	1.88307	85959	83732	81613	79593	77663
4	1.75814	74042	72339	70700	69121	67597
5	1.66125	64701	63322	61986	60690	59431
6	1.58208	57018	55861	54733	53634	52561
7	1.51515	50494	49496	48520	47566	46632
8	1.45718	44823	43946	43086	42243	41417
9	1.40605	39809	39027	38258	37503	36762
10	1.36032	35315	34609	33915	33231	32558
11	1.31896	31243	30600	29967	29342	28727
12	1.28120	27522	26931	26349	25774	25207
13	1.24647	24095	23549	23010	22478	21952
14	1.21432	20919	20412	19910	19415	18925
15	1.18440	17961	17487	17018	16554	16096
16	1.15642	15192	14748	14307	13872	13440
17	1.13013	12590	12171	11757	11346	10939
18	1.10536	10136	09740	09348	08960	08574
19	1.08193	07814	07439	07067	06699	06333
20	1.05970	05611	05254	04901	04550	04202
21	1.03857	03515	03175	02838	02504	02172
22	1.01843	01516	01192	00870	00550	00233
23	0.99918	99606	99296	98988	98682	98378
24	0.98077	97777	97480	97184	96891	96600
25	0.96310	96023	95738	95454	95172	94892
26	0.94614	94338	94063	93790	93519	93250
27	0.92982	92716	92452	92189	91928	91669
28	0.91411	91154	90899	90646	90394	90143
29	0.89894	89647	89401	89156	88913	88671
30	0.88430	88191	87953	87717	87481	87247
31	0.87015	86783	86553	86324	86096	85870
32	0.85644	85420	85197	84976	84755	84535
33	0.84317	84100	83884	83669	83455	83242
34	0.83030	82819	82609	82401	82193	81986
35	0.81780	81576	81372	81169	80967	80767
36	0.80567	80368	80170	79973	79777	79581
37	0.79387	79193	79001	78809	78618	78428
38	0.78239	78051	77863	77677	77491	77306
39	0.77122	76938	76756	76574	76393	76212
40	0.76033	75854	75676	75499	75323	75147
41	0.74972	74797	74624	74451	74279	74107
42	0.73937	73767	73597	73429	73261	73093
43	0.72927	72760	72595	72430	72266	72103
44	0.71940	71778	71616	71455	71295	71136
45	0.70976	70818	70660	70503	70346	70190
46	0.70034	69880	69725	69571	69418	69265
47	0.69113	68962	68811	68660	68510	68361
48	0.68212	68064	67916	67769	67622	67476
49	0.67330	67185	67040	66896	66752	66609
50	0.66466	66324	66182	66041	65900	65760
51	0.65620	65481	65342	65204	65066	64928
52	0.64791	64655	64519	64383	64248	64113
53	0.63978	63845	63711	63578	63445	63313
54	0.63181	63050	62919	62789	62659	62529
55	0.62400	62271	62142	62014	61887	61759
56	0.61632	61506	61380	61254	61129	61004
57	0.60879	60755	60631	60508	60385	60262
58	0.60140	60018	59897	59775	59654	59534
59	0.59414	59294	59175	59056	58937	58818

MIDDLE TIME.

0 HOUR.

M	0″	10″	20″	30″	40″	50″
0	Inf. Neg					
0	2.	16270	46373	63982	76476	86167
1	2.94085					
1	3.	00779	06578	11694	16269	20408
2	3.24187	27663	30882	33878	36681	39313
3	3.41796	44144	46371	48490	50510	52440
4	3.54289	56061	57764	59403	60982	62506
5	3.63978	65402	66781	68117	69413	70672
6	3.71895	73085	74242	75370	76469	77542
7	3.78588	79609	80607	81583	82537	83471
8	3.84385	85280	86157	87017	87860	88686
9	3.89498	90294	91076	91845	92600	93341
10	3.94071	94788	95494	96188	96872	97545
11	3.98207	98860	99503			
11	4.			00136	00761	01376
12	4.01983	02581	03172	03754	04329	04896
13	4.05456	06008	06554	07093	07625	08151
14	4.08671	09184	09691	10193	10688	11178
15	4.11663	12142	12616	13085	13549	14007
16	4.14461	14911	15355	15796	16231	16663
17	4.17090	17513	17932	18346	18757	19164
18	4.19567	19967	20363	20755	21143	21529
19	4.21910	22289	22664	23036	23404	23770
20	4.24133	24492	24849	25202	25553	25901
21	4.26246	26588	26928	27265	27599	27931
22	4.28260	28587	28911	29233	29553	29870
23	4.30185	30497	30807	31115	31421	31725
24	4.32026	32326	32623	32919	33212	33503
25	4.33793	34080	34365	34649	34931	35211
26	4.35489	35765	36040	36313	36584	36853
27	4.37121	37387	37651	37914	38175	38434
28	4.38692	38949	39204	39457	39709	39960
29	4.40209	40456	40702	40947	41190	41432
30	4.41673	41912	42150	42386	42622	42856
31	4.43088	43320	43550	43779	44007	44233
32	4.44459	44683	44906	45127	45348	45568
33	4.45786	46003	46219	46434	46648	46861
34	4.47073	47284	47494	47702	47910	48117
35	4.48323	48527	48731	48934	49136	49336
36	4.49536	49735	49933	50130	50326	50522
37	4.50716	50910	51102	51294	51485	51675
38	4.51864	52052	52240	52426	52612	52797
39	4.52981	53165	53347	53529	53710	53891
40	4.54070	54249	54427	54604	54780	54956
41	4.55131	55306	55479	55652	55824	55996
42	4.56166	56336	56506	56674	56842	57010
43	4.57176	57343	57508	57673	57837	58000
44	4.58163	58325	58487	58648	58808	58967
45	4.59127	59285	59443	59600	59757	59913
46	4.60069	60223	60378	60532	60685	60838
47	4.60990	61141	61292	61443	61593	61742
48	4.61891	62039	62187	62334	62481	62627
49	4.62773	62918	63063	63207	63351	63494
50	4.63637	63779	63921	64062	64203	64343
51	4.64483	64622	64761	64899	65037	65175
52	4.65312	65448	65584	65720	65855	65990
53	4.66125	66258	66392	66525	66658	66790
54	4.66922	67053	67184	67314	67444	67574
55	4.67703	67832	67961	68089	68216	68344
56	4.68471	68597	68723	68849	68974	69099
57	4.69224	69348	69472	69595	69718	69841
58	4.69963	70085	70206	70328	70449	70569
59	4.70689	70809	70928	71047	71166	71285

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME. 1 HOUR.							MIDDLE TIME. 1 HOUR.						
M	0″	10″	20″	30″	40″	50″	M	0″	10″	20″	30″	40″	50″
0	0.58700	58583	58465	58348	58232	58115	0	4.71403	71520	71638	71755	71871	71988
1	0.57999	57884	57768	57653	57539	57424	1	4.72104	72219	72335	72450	72564	72679
2	0.57310	57196	57083	56970	56857	56745	2	4.72793	72907	73020	73133	73246	73358
3	0.56633	56521	56409	56298	56187	56076	3	4.73470	73582	73694	73805	73916	74027
4	0.55966	55856	55747	55637	55528	55419	4	4.74137	74247	74356	74466	74575	74684
5	0.55311	55203	55095	54987	54880	54773	5	4.74792	74900	75008	75116	75223	75330
6	0.54666	54559	54453	54347	54242	54136	6	4.75437	75544	75650	75756	75861	75967
7	0.54031	53926	53822	53718	53614	53510	7	4.76072	76177	76281	76385	76489	76593
8	0.53406	53303	53200	53098	52995	52893	8	4.76697	76800	76903	77005	77108	77210
9	0.52791	52690	52589	52487	52387	52286	9	4.77312	77413	77514	77616	77716	77817
10	0.52186	52086	51986	51886	51787	51688	10	4.77917	78017	78117	78217	78316	78415
11	0.51589	51491	51393	51294	51197	51099	11	4.78514	78612	78710	78809	78906	79004
12	0.51002	50905	50808	50711	50615	50519	12	4.79101	79198	79295	79392	79488	79584
13	0.50423	50327	50232	50137	50042	49947	13	4.79680	79776	79871	79966	80061	80156
14	0.49852	49758	49664	49570	49477	49383	14	4.80251	80345	80439	80533	80626	80720
15	0.49290	49197	49104	49012	48920	48828	15	4.80813	80906	80999	81091	81183	81275
16	0.48736	48644	48553	48462	48371	48280	16	4.81367	81459	81550	81641	81732	81823
17	0.48189	48099	48009	47919	47829	47740	17	4.81914	82004	82094	82184	82274	82363
18	0.47650	47561	47473	47384	47295	47207	18	4.82453	82542	82630	82719	82808	82896
19	0.47119	47031	46944	46856	46769	46682	19	4.82984	83072	83159	83247	83334	83421
20	0.46595	46508	46422	46335	46249	46163	20	4.83508	83595	83681	83768	83854	83940
21	0.46078	45992	45907	45822	45737	45652	21	4.84025	84111	84196	84281	84366	84451
22	0.45567	45483	45399	45315	45231	45147	22	4.84536	84620	84704	84788	84872	84956
23	0.45064	44981	44898	44815	44732	44649	23	4.85039	85122	85205	85288	85371	85454
24	0.44567	44485	44403	44321	44239	44158	24	4.85536	85618	85700	85782	85864	85945
25	0.44077	43995	43915	43834	43753	43673	25	4.86026	86108	86188	86269	86350	86430
26	0.43592	43512	43432	43353	43273	43194	26	4.86511	86591	86671	86750	86830	86909
27	0.43114	43035	42956	42878	42799	42721	27	4.86989	87068	87147	87225	87304	87382
28	0.42642	42564	42486	42409	42331	42254	28	4.87461	87539	87617	87694	87772	87849
29	0.42176	42099	42022	41945	41869	41792	29	4.87927	88004	88081	88158	88234	88311
30	0.41716	41640	41664	41488	41412	41337	30	4.88387	88463	88539	88615	88691	88766
31	0.41261	41186	41111	41036	40961	40887	31	4.88842	88917	88992	89067	89142	89216
32	0.40812	40738	40664	40590	40516	40442	32	4.89291	89365	89439	89513	89587	89661
33	0.40368	40295	40222	40149	40076	40003	33	4.89735	89808	89881	89954	90027	90100
34	0.39930	39857	39785	39713	39641	39569	34	4.90173	90246	90318	90390	90462	90534
35	0.39497	39425	39354	39282	39211	39140	35	4.90606	90678	90749	90821	90892	90963
36	0.39069	38998	38927	38856	38786	38716	36	4.91034	91105	91176	91247	91317	91387
37	0.38646	38575	38506	38436	38366	38297	37	4.91457	91528	91597	91667	91737	91806
38	0.38227	38158	38089	38020	37951	37882	38	4.91876	91945	92014	92083	92152	92221
39	0.37814	37745	37677	37609	37541	37473	39	4.92289	92358	92426	92494	92562	92630
40	0.37405	37338	37270	37203	37135	37068	40	4.92698	92765	92833	92900	92968	93035
41	0.37001	36934	36867	36801	36734	36668	41	4.93102	93169	93236	93302	93369	93435
42	0.36602	36535	36469	36403	36338	36272	42	4.93501	93568	93634	93700	93765	93831
43	0.36206	36141	36076	36011	35946	35881	43	4.93897	93962	94027	94092	94157	94222
44	0.35816	35751	35687	35622	35558	35494	44	4.94287	94352	94416	94481	94545	94609
45	0.35429	35365	35302	35238	35174	35111	45	4.94674	94738	94801	94865	94929	94992
46	0.35047	34984	34921	34858	34795	34732	46	4.95056	95119	95182	95245	95308	95371
47	0.34669	34607	34544	34482	34420	34357	47	4.95434	95496	95559	95621	95683	95746
48	0.34295	34233	34172	34110	34048	33987	48	4.95808	95870	95931	95993	96055	96116
49	0.33925	33864	33803	33742	33681	33620	49	4.96178	96239	96300	96361	96422	96483
50	0.33559	33499	33438	33378	33318	33257	50	4.96544	96604	96665	96725	96785	96846
51	0.33197	33137	33078	33018	32958	32899	51	4.96906	96966	97025	97085	97145	97204
52	0.32839	32780	32720	32661	32602	32543	52	4.97264	97323	97383	97442	97501	97560
53	0.32485	32426	32367	32309	32250	32192	53	4.97618	97677	97736	97794	97853	97911
54	0.32134	32076	32018	31960	31902	31844	54	4.97969	98027	98085	98143	98201	98259
55	0.31787	31729	31672	31614	31557	31500	55	4.98316	98374	98431	98489	98546	98603
56	0.31443	31386	31329	31272	31216	31159	56	4.98660	98717	98774	98831	98887	98944
57	0.31103	31046	30990	30934	30878	30822	57	4.99000	99057	99113	99169	99225	99281
58	0.30766	30710	30655	30599	30544	30488	58	4.99337	99393	99448	99504	99559	99615
59	0.30433	30378	30323	30268	30213	30158	59	4.99670	99725	99780	99835	99890	99945

TABLE XXIII.

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME. 2 HOURS.

M	0″	10″	20″	30″	40″	50″
0	0.30103	30048	29994	29939	29885	29831
1	0.29776	29722	29668	29614	29561	29507
2	0.29453	29400	29346	29293	29239	29186
3	0.29133	29080	29027	28974	28921	28869
4	0.28816	28764	28711	28659	28607	28554
5	0.23502	28450	23398	28346	28295	28243
6	0.28191	28140	28089	28037	27986	27935
7	0.27884	27833	27782	27731	27680	27630
8	0.27579	27529	27478	27428	27378	27327
9	0.27277	27227	27177	27127	27078	27028
10	0.26978	26929	26879	26830	26781	26731
11	0.26682	26633	26584	26535	26487	26438
12	0.26389	26341	26292	26244	26195	26147
13	0.26099	26051	26003	25955	25907	25859
14	0.25811	25763	25716	25668	25621	25573
15	0.25526	25479	25432	25385	25338	25291
16	0.25244	25197	25150	25104	25057	25011
17	0.24964	24918	24872	24825	24779	24733
18	0.24687	24641	24595	24550	24504	24458
19	0.24413	24367	24322	24276	24231	24186
20	0.24141	24096	24051	24006	23961	23916
21	0.23871	23827	23782	23738	23693	23649
22	0.23605	23560	23516	23472	23428	23384
23	0.23340	23296	23253	23209	23165	23122
24	0.23078	23035	22991	22948	22905	22862
25	0.22819	22775	22732	22690	22647	22604
26	0.22561	22519	22476	22433	22391	22349
27	0.22306	22264	22222	22130	22138	22096
28	0.22054	22012	21970	21928	21887	21845
29	0.21803	21762	21720	21679	21638	21596
30	0.21555	21514	21473	21432	21391	21350
31	0.21309	21269	21228	21187	21147	21106
32	0.21066	21025	20985	20945	20905	20864
33	0.20824	20784	20744	20704	20665	20625
34	0.20585	20545	20506	20466	20427	20387
35	0.20348	20309	20269	20230	20191	20152
36	0.20113	20074	20035	19996	19957	19919
37	0.19880	19841	19803	19764	19726	19687
38	0.19649	19611	19572	19534	19496	19458
39	0.19420	19382	19344	19306	19269	19231
40	0.19193	19156	19118	19081	19043	19006
41	0.18968	18931	18894	18857	18820	18783
42	0.13746	18709	18672	18635	18598	18561
43	0.18525	18488	18451	18415	18378	18342
44	0.18306	18269	18233	18197	18161	18125
45	0.18089	13053	18017	17981	17945	17909
46	0.17874	17838	17802	17767	17731	17696
47	0.17660	17625	17590	17554	17519	17484
48	0.17449	17414	17379	17344	17309	17274
49	0.17239	17205	17170	17135	17101	17066
50	0.17032	16997	16963	16928	16894	16860
51	0.16826	16792	16758	16723	16690	16656
52	0.16622	16588	16554	16520	16487	16453
53	0.16419	16386	16352	16319	16285	16252
54	0.16219	16186	16152	16119	16086	16053
55	0.16020	15987	15954	15921	15888	15856
56	0.15823	15790	15758	15725	15692	15660
57	0.15627	15595	15563	15530	15498	15466
58	0.15434	15402	15370	15338	15306	15274
59	0.15242	15210	15178	15146	15115	15083

MIDDLE TIME. 2 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.00000	00055	00109	00164	00218	00272
1	5.00327	00381	00435	00489	00542	00596
2	5.00650	00703	00757	00810	00864	00917
3	5.00970	01023	01076	01129	01182	01234
4	5.01287	01339	01392	01444	01496	01549
5	5.01601	01653	01705	01757	01808	01860
6	5.01912	01963	02014	02066	02117	02168
7	5.02219	02270	02321	02372	02423	02473
8	5.02524	02574	02625	02675	02725	02776
9	5.02826	02876	02926	02976	03025	03075
10	5.03125	03174	03224	03273	03322	03372
11	5.03421	03470	03519	03568	03616	03665
12	5.03714	03762	03811	03859	03908	03956
13	5.04004	04052	04100	04148	04196	04244
14	5.04292	04340	04387	04435	04482	04530
15	5.04577	04624	04671	04718	04765	04812
16	5.04859	04906	04953	04999	05046	05092
17	5.05139	05185	05231	05278	05324	05370
18	5.05416	05462	05508	05553	05599	05645
19	5.05690	05736	05781	05827	05872	05917
20	5.05962	06007	06052	06097	06142	06187
21	5.06232	06276	06321	06365	06410	06454
22	5.06498	06543	06587	06631	06675	06719
23	5.06763	06807	06850	06894	06938	06981
24	5.07025	07068	07112	07155	07198	07241
25	5.07284	07328	07371	07413	07456	07499
26	5.07542	07584	07627	07670	07712	07754
27	5.07797	07839	07881	07923	07965	08007
28	5.08049	08091	08133	08175	08216	08258
29	5.08300	08341	08383	08424	08465	08507
30	5.08548	08589	08630	08671	08712	08753
31	5.08794	08834	08875	08916	08966	08997
32	5.09037	09078	09118	09158	09198	09239
33	5.09279	09319	09359	09399	09438	09478
34	5.09518	09558	09597	09637	09676	09716
35	5.09755	09794	09834	09873	09912	09951
36	5.09990	10029	10068	10107	10146	10184
37	5.10223	10262	10300	10339	10377	10416
38	5.10454	10492	10531	10569	10607	10645
39	5.10683	10721	10759	10797	10834	10872
40	5.10910	10947	10985	11022	11060	11097
41	5.11135	11172	11209	11246	11283	11320
42	5.11357	11394	11431	11468	11505	11542
43	5.11578	11615	11652	11688	11725	11761
44	5.11797	11834	11870	11906	11942	11978
45	5.12014	12050	12086	12122	12158	12194
46	5.12229	12265	12301	12336	12372	12407
47	5.12443	12478	12513	12549	12584	12619
48	5.12654	12689	12724	12759	12794	12829
49	5.12864	12898	12933	12968	13002	13037
50	5.13071	13106	13140	13175	13209	13243
51	5.13277	13311	13345	13380	13413	13447
52	5.13481	13515	13549	13583	13616	13650
53	5.13684	13717	13751	13784	13818	13851
54	5.13884	13917	13951	13984	14017	14050
55	5.14083	14116	14149	14182	14215	14247
56	5.14280	14313	14345	14378	14411	14443
57	5.14476	14508	14540	14573	14605	14637
58	5.14669	14701	14733	14765	14797	14829
59	5.14861	14893	14925	14957	14988	15020

TABLE XXIII.

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME.						
3 HOURS.						
M	0″	10″	20″	30″	40″	50″
0	0.15051	15020	14988	14957	14926	14894
1	0.14863	14832	14800	14769	14738	14707
2	0.14676	14645	14614	14583	14552	14521
3	0.14490	14460	14429	14398	14368	14337
4	0.14307	14276	14246	14215	14185	14155
5	0.14124	14094	14064	14034	14004	13974
6	0.13944	13914	13884	13854	13824	13794
7	0.13765	13735	13705	13676	13646	13617
8	0.13587	13558	13528	13499	13470	13441
9	0.13411	13382	13353	13324	13295	13266
10	0.13237	13208	13179	13150	13121	13093
11	0.13064	13035	13007	12978	12950	12921
12	0.12893	12864	12836	12808	12779	12751
13	0.12723	12695	12666	12638	12610	12582
14	0.12554	12526	12499	12471	12443	12415
15	0.12387	12360	12332	12305	12277	12249
16	0.12222	12195	12167	12140	12113	12085
17	0.12058	12031	12004	11977	11949	11922
18	0.11895	11868	11842	11815	11788	11761
19	0.11734	11708	11681	11654	11628	11601
20	0.11575	11548	11522	11495	11469	11443
21	0.11416	11390	11364	11338	11312	11285
22	0.11259	11233	11207	11181	11156	11130
23	0.11104	11078	11052	11027	11001	10975
24	0.10950	10924	10899	10873	10848	10822
25	0.10797	10772	10746	10721	10696	10671
26	0.10646	10620	10595	10570	10545	10520
27	0.10496	10471	10446	10421	10396	10371
28	0.10347	10322	10298	10273	10248	10224
29	0.10199	10175	10151	10126	10102	10078
30	0.10053	10029	10005	09981	09957	09933
31	0.09909	09885	09861	09837	09813	09789
32	0.09765	09741	09718	09694	09670	09647
33	0.09623	09599	09576	09552	09529	09506
34	0.09482	09459	09435	09412	09389	09366
35	0.09343	09319	09296	09273	09250	09227
36	0.09204	09181	09158	09136	09113	09090
37	0.09067	09044	09022	08999	08977	08954
38	0.08931	08909	08886	08864	08842	08819
39	0.08797	08775	08752	08730	08708	08686
40	0.08664	08641	08619	08597	08575	08553
41	0.08531	08510	08488	08466	08444	08422
42	0.08401	08379	08357	08336	08314	08293
43	0.08271	08250	08228	08207	08185	08164
44	0.08143	08121	08100	08079	08058	08036
45	0.08015	07994	07973	07952	07931	07910
46	0.07889	07868	07848	07827	07806	07785
47	0.07765	07744	07723	07703	07682	07661
48	0.07641	07620	07600	07579	07559	07539
49	0.07518	07498	07478	07458	07437	07417
50	0.07397	07377	07357	07337	07317	07297
51	0.07277	07257	07237	07217	07197	07178
52	0.07158	07138	07119	07099	07079	07060
53	0.07040	07021	07001	06982	06962	06943
54	0.06923	06904	06885	06866	06846	06827
55	0.06808	06789	06770	06751	06731	06712
56	0.06693	06674	06656	06637	06618	06599
57	0.06580	06561	06543	06524	06505	06487
58	0.06468	06449	06431	06412	06394	06375
59	0.06357	06338	06320	06302	06283	06265

MIDDLE TIME.						
3 HOURS.						
M	0″	10″	20″	30″	40″	50″
0	5.15051	15083	15115	15146	15177	15209
1	5.15240	15271	15303	15334	15365	15396
2	5.15427	15458	15489	15520	15551	15582
3	5.15613	15643	15674	15705	15735	15766
4	5.15796	15827	15857	15888	15918	15948
5	5.15979	16009	16039	16069	16099	16129
6	5.16159	16189	16219	16249	16279	16309
7	5.16338	16368	16398	16427	16457	16486
8	5.16516	16545	16575	16604	16633	16662
9	5.16692	16721	16750	16779	16808	16837
10	5.16866	16895	16924	16953	16982	17010
11	5.17039	17068	17096	17125	17153	17182
12	5.17210	17239	17267	17295	17324	17352
13	5.17380	17408	17437	17465	17493	17521
14	5.17549	17577	17604	17632	17660	17688
15	5.17716	17743	17771	17798	17826	17854
16	5.17881	17908	17936	17963	17990	18018
17	5.18045	18072	18099	18126	18154	18181
18	5.18208	18235	18261	18288	18315	18342
19	5.18369	18395	18422	18449	18475	18502
20	5.18528	18555	18581	18608	18634	18660
21	5.18687	18713	18739	18765	18791	18818
22	5.18844	18870	18896	18922	18947	18973
23	5.18999	19025	19051	19076	19102	19128
24	5.19153	19179	19204	19230	19255	19281
25	5.19306	19331	19357	19382	19407	19432
26	5.19457	19483	19508	19533	19558	19583
27	5.19607	19632	19657	19682	19707	19732
28	5.19756	19781	19805	19830	19855	19879
29	5.19904	19928	19952	19977	20001	20025
30	5.20050	20074	20098	20122	20146	20170
31	5.20194	20218	20242	20266	20290	20314
32	5.20338	20362	20385	20409	20433	20456
33	5.20480	20504	20527	20551	20574	20597
34	5.20621	20644	20668	20691	20714	20737
35	5.20760	20784	20807	20830	20853	20876
36	5.20899	20922	20945	20967	20990	21013
37	5.21036	21059	21081	21104	21126	21149
38	5.21172	21194	21217	21239	21261	21284
39	5.21306	21328	21351	21373	21395	21417
40	5.21439	21462	21484	21506	21528	21550
41	5.21572	21593	21615	21637	21659	21681
42	5.21702	21724	21746	21767	21789	21810
43	5.21832	21853	21875	21896	21918	21939
44	5.21960	21982	22003	22024	22045	22067
45	5.22088	22109	22130	22151	22172	22193
46	5.22214	22235	22255	22276	22297	22318
47	5.22338	22359	22380	22400	22421	22442
48	5.22462	22483	22503	22524	22544	22564
49	5.22585	22605	22625	22645	22666	22686
50	5.22706	22726	22746	22766	22786	22806
51	5.22826	22846	22866	22886	22906	22925
52	5.22945	22965	22984	23004	23024	23043
53	5.23063	23082	23102	23121	23141	23160
54	5.23180	23199	23218	23237	23257	23276
55	5.23295	23314	23333	23352	23372	23391
56	5.23410	23429	23447	23466	23485	23504
57	5.23523	23542	23560	23579	23598	23616
58	5.23635	23654	23672	23691	23709	23728
59	5.23746	23765	23783	23801	23820	23838

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME.						
4 HOURS.						
M	0″	10″	20″	30″	40″	50″
0	0.06247	06229	06211	06192	06174	06156
1	0.06138	06120	06102	06084	06066	06048
2	0.06030	06012	05995	05977	05959	05941
3	0.05924	05906	05888	05871	05853	05836
4	0.05818	05801	05783	05766	05748	05731
5	0.05714	05696	05679	05662	05645	05627
6	0.05610	05593	05576	05559	05542	05525
7	0.05508	05491	05474	05457	05440	05423
8	0.05407	05390	05373	05356	05340	05323
9	0.05306	05290	05273	05257	05240	05224
10	0.05207	05191	05174	05158	05142	05125
11	0.05109	05093	05077	05060	05044	05028
12	0.05012	04996	04980	04964	04948	04932
13	0.04916	04900	04884	04868	04852	04837
14	0.04821	04805	04789	04774	04758	04743
15	0.04727	04711	04696	04680	04665	04649
16	0.04634	04619	04603	04588	04573	04557
17	0.04542	04527	04512	04496	04481	04466
18	0.04451	04436	04421	04406	04391	04376
19	0.04361	04346	04332	04317	04302	04287
20	0.04272	04258	04243	04228	04214	04199
21	0.04185	04170	04156	04141	04127	04112
22	0.04098	04083	04069	04055	04040	04026
23	0.04012	03998	03983	03969	03955	03941
24	0.03927	03913	03899	03885	03871	03857
25	0.03843	03829	03815	03802	03788	03774
26	0.03760	03747	03733	03719	03706	03692
27	0.03678	03665	03651	03638	03624	03611
28	0.03597	03584	03571	03557	03544	03531
29	0.03517	03504	03491	03478	03465	03452
30	0.03438	03425	03412	03399	03386	03373
31	0.03360	03348	03335	03322	03309	03296
32	0.03283	03271	03258	03245	03233	03220
33	0.03207	03195	03182	03170	03157	03145
34	0.03132	03120	03107	03095	03083	03070
35	0.03058	03046	03034	03021	03009	02997
36	0.02985	02973	02961	02949	02937	02925
37	0.02913	02901	02889	02877	02865	02853
38	0.02841	02829	02818	02806	02794	02783
39	0.02771	02759	02748	02736	02724	02713
40	0.02701	02690	02678	02667	02656	02644
41	0.02633	02622	02610	02599	02588	02577
42	0.02565	02554	02543	02532	02521	02510
43	0.02499	02488	02477	02466	02455	02444
44	0.02433	02422	02411	02400	02390	02379
45	0.02368	02357	02347	02336	02326	02315
46	0.02304	02294	02283	02273	02262	02252
47	0.02241	02231	02221	02210	02200	02190
48	0.02179	02169	02159	02149	02139	02128
49	0.02118	02108	02098	02088	02078	02068
50	0.02058	02048	02038	02028	02018	02009
51	0.01999	01989	01979	01969	01960	01950
52	0.01940	01931	01921	01912	01902	01892
53	0.01883	01873	01864	01854	01845	01836
54	0.01826	01817	01808	01798	01789	01780
55	0.01771	01761	01752	01743	01734	01725
56	0.01716	01707	01698	01689	01680	01671
57	0.01662	01653	01644	01635	01627	01618
58	0.01609	01600	01591	01583	01574	01565
59	0.01557	01548	01540	01531	01523	01514

MIDDLE TIME.						
4 HOURS.						
M	0″	10″	20″	30″	40″	50″
0	5.23856	23874	23892	23911	23929	23947
1	5.23965	23983	24001	24019	24037	24055
2	5.24073	24091	24108	24126	24144	24162
3	5.24179	24197	24215	24232	24250	24267
4	5.24285	24302	24320	24337	24355	24372
5	5.24389	24407	24424	24441	24458	24476
6	5.24493	24510	24527	24544	24561	24578
7	5.24595	24612	24629	24646	24663	24680
8	5.24696	24713	24730	24747	24763	24780
9	5.24797	24813	24830	24846	24863	24879
10	5.24896	24912	24929	24945	24961	24978
11	5.24994	25010	25026	25043	25059	25075
12	5.25091	25107	25123	25139	25155	25171
13	5.25187	25203	25219	25235	25251	25266
14	5.25282	25298	25314	25329	25345	25360
15	5.25376	25392	25407	25423	25438	25454
16	5.25469	25484	25500	25515	25530	25546
17	5.25561	25576	25591	25607	25622	25637
18	5.25652	25667	25682	25697	25712	25727
19	5.25742	25757	25771	25786	25801	25816
20	5.25831	25845	25860	25875	25889	25904
21	5.25918	25933	25947	25962	25976	25991
22	5.26005	26020	26034	26048	26063	26077
23	5.26091	26105	26120	26134	26148	26162
24	5.26176	26190	26204	26218	26232	26246
25	5.26260	26274	26288	26301	26315	26329
26	5.26343	26356	26370	26384	26397	26411
27	5.26425	26438	26452	26465	26479	26492
28	5.26506	26519	26532	26546	26559	26572
29	5.26586	26599	26612	26625	26638	26651
30	5.26665	26678	26691	26704	26717	26730
31	5.26743	26755	26768	26781	26794	26807
32	5.26820	26832	26845	26858	26870	26883
33	5.26896	26908	26921	26933	26946	26958
34	5.26971	26983	26996	27008	27020	27033
35	5.27045	27057	27069	27082	27094	27106
36	5.27118	27130	27142	27154	27166	27178
37	5.27190	27202	27214	27226	27238	27250
38	5.27262	27274	27285	27297	27309	27320
39	5.27332	27344	27355	27367	27379	27390
40	5.27402	27413	27425	27436	27447	27459
41	5.27470	27481	27493	27504	27515	27526
42	5.27538	27549	27560	27571	27582	27593
43	5.27604	27615	27626	27637	27648	27659
44	5.27670	27681	27692	27703	27713	27724
45	5.27735	27746	27756	27767	27777	27788
46	5.27799	27809	27820	27830	27841	27851
47	5.27862	27872	27882	27893	27903	27913
48	5.27924	27934	27944	27954	27964	27975
49	5.27985	27995	28005	28015	28025	28035
50	5.28045	28055	28065	28075	28085	28094
51	5.28104	28114	28124	28134	28143	28153
52	5.28163	28172	28182	28191	28201	28211
53	5.28220	28230	28239	28249	28258	28267
54	5.28277	28286	28295	28305	28314	28323
55	5.28332	28342	28351	28360	28369	28378
56	5.28387	28396	28405	28414	28423	28432
57	5.28441	28450	28459	28468	28476	28485
58	5.28494	28503	28512	28520	28529	28538
59	5.28546	28555	28563	28572	28580	28589

To find the Latitude by two Altitudes of the Sun.

HALF ELAPSED TIME. 5 HOURS.							MIDDLE TIME. 5 HOURS.						
M	0″	10″	20″	30″	40″	50″	M	0″	10″	20″	30″	40″	50″
0	0.01506	01497	01489	01480	01472	01464	0	5.28597	28606	28614	28623	28631	28639
1	0.01455	01447	01439	01430	01422	01414	1	5.28648	28656	28664	28673	28681	28689
2	0.01406	01398	01390	01381	01373	01365	2	5.28697	28705	28713	28722	28730	28738
3	0.01357	01349	01341	01333	01325	01317	3	5.28746	28754	28762	28770	28778	28786
4	0.01310	01302	01294	01286	01278	01271	4	5.28793	28801	28809	28817	28825	28832
5	0.01263	01255	01247	01240	01232	01224	5	5.28840	28848	28856	28863	28871	28879
6	0.01217	01209	01202	01194	01187	01179	6	5.28886	28894	28901	28909	28916	28924
7	0.01172	01164	01157	01150	01142	01135	7	5.28931	28939	28946	28953	28961	28968
8	0.01128	01120	01113	01106	01099	01091	8	5.28975	28983	28990	28997	29004	29012
9	0.01084	01077	01070	01063	01056	01049	9	5.29019	29026	29033	29040	29047	29054
10	0.01042	01035	01028	01021	01014	01007	10	5.29061	29068	29075	29082	29089	29096
11	0.01000	00993	00987	00980	00973	00966	11	5.29103	29110	29116	29123	29130	29137
12	0.00960	00953	00946	00940	00933	00926	12	5 29143	29150	29157	29163	29170	29177
13	0.00920	00913	00907	00900	00894	00887	13	5.29183	29190	29196	29203	29209	29216
14	0.00881	00874	00868	00862	00855	00849	14	5.29222	29229	29235	29241	29248	29254
15	0.00843	00836	00830	00824	00818	00811	15	5.29260	29267	29273	29279	29285	29292
16	0.00805	00799	00793	00787	00781	00775	16	5.29298	29304	29310	29316	29322	29328
17	0.00769	00763	00757	00751	00745	00739	17	5.29334	29340	29346	29352	29358	29364
18	0.00733	00728	00722	00716	00710	00704	18	5.29370	29375	29381	29387	29393	29399
19	0.00699	00693	00687	00682	00676	00670	19	5.29404	29410	29416	29421	29427	29433
20	0.00665	00659	00654	00648	00643	00637	20	5.29438	29444	29449	29455	29460	29466
21	0.00632	00626	00621	00616	00610	00605	21	5.29471	29477	29482	29487	29493	29498
22	0.00600	00594	00589	00584	00579	00574	22	5.29503	29509	29514	29519	29524	29529
23	0.00568	00563	00558	00553	00548	00543	23	5.29535	29540	29545	29550	29555	29560
24	0.00538	00533	00528	00523	00518	00513	24	5.29565	29570	29575	29580	29585	29590
25	0.00508	00504	00499	00494	00489	00484	25	5.29595	29599	29604	29609	29614	29619
26	0.00480	00475	00470	00466	00461	00456	26	5.29623	29628	29633	29637	29642	29647
27	0.00452	00447	00443	00438	00434	00429	27	5.29651	29656	29660	29665	29669	29674
28	0.00425	00420	00416	00412	00407	00403	28	5.29678	29683	29687	29691	29696	29700
29	0.00399	00394	00390	00386	00382	00377	29	5.29704	29709	29713	29717	29721	29726
30	0.00373	00369	00365	00361	00357	00353	30	5.29730	29734	29738	29742	29746	29750
31	0.00349	00345	00341	00337	00333	00329	31	5.29754	29758	29762	29766	29770	29774
32	0.00325	00321	00317	00313	00310	00306	32	5.29778	29782	29786	29790	29793	29797
33	0.00302	00298	00295	00291	00287	00284	33	5.29801	29805	29808	29812	29816	29819
34	0.00280	00276	00273	00269	00266	00262	34	5.29823	29827	29830	29834	29837	29841
35	0.00259	00255	00252	00249	00245	00242	35	5.29844	29848	29851	29854	29858	29861
36	0.00239	00235	00232	00229	00225	00222	36	5.29864	29868	29871	29874	29878	29881
37	0.00219	00216	00213	00210	00207	00203	37	5.29884	29887	29890	29893	29896	29900
38	0.00200	00197	00194	00191	00188	00185	38	5.29903	29906	29909	29912	29915	29918
39	0.00183	00180	00177	00174	00171	00168	39	5.29920	29923	29926	29929	29932	29935
40	0.00166	00163	00160	00157	00155	00152	40	5.29937	29940	29943	29946	29948	29951
41	0.00149	00147	00144	00142	00139	00137	41	5.29954	29956	29959	29961	29964	29966
42	0.00134	00132	00129	00127	00124	00122	42	5.29969	29971	29974	29976	29979	29981
43	0.00120	00117	00115	00113	00110	00108	43	5.29983	29986	29988	29990	29993	29995
44	0.00106	00104	00102	00099	00097	00095	44	5.29997	29999	30001	30004	30006	30008
45	0.00093	00091	00089	00087	00085	00083	45	5.30010	30012	30014	30016	30018	30020
46	0.00081	00079	00077	00075	00074	00072	46	5.30022	30024	30026	30028	30029	30031
47	0.00070	00068	00066	00065	00063	00061	47	5.30033	30035	30037	30038	30040	30042
48	0.00060	00058	00056	00055	00053	00052	48	5.30043	30045	30047	30048	30050	30051
49	0.00050	00049	00047	00046	00044	00043	49	5.30053	30054	30056	30057	30059	30060
50	0.00041	00040	00039	00037	00036	00035	50	5.30062	30063	30064	30066	30067	30068
51	0.00033	00032	00031	00030	00029	00028	51	5.30070	30071	30072	30073	30074	30075
52	0.00026	00025	00024	00023	00022	00021	52	5.30077	30078	30079	30080	30081	30082
53	0.00020	00019	00018	00017	00017	00016	53	5.30083	30084	30085	30086	30086	30087
54	0.00015	00014	00013	00013	00012	00011	54	5.30088	30089	30090	30090	30091	30092
55	0.00010	00010	00009	00008	00008	00007	55	5.30093	30093	30094	30095	30095	30096
56	0.00007	00006	00006	00005	00005	00004	56	5.30096	30097	30097	30098	30098	30099
57	0.00004	00003	00003	00003	00002	00002	57	5.30099	30100	30100	30100	30101	30101
58	0.00002	00001	00001	00001	00001	00001	58	5.30101	30102	30102	30102	30102	30102
59	0.00000	00000	00000	00000	00000	00000	59	5.30103	30103	30103	30103	30103	30103

TABLE XXIII.

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

0 HOUR.

M	0″	10″	20″	30″	40″	50″
0	Inf. Neg.					
	8.	42230				
	9.		02436	37654	62642	82024
1	9.97860					
	0.	11250	22846	33079	42230	50509
2	0.58066	65019	71455	77448	83054	88319
3	0.93284	97980				
	1.		02435	06673	10714	14575
4	1.18271	21317	25224	28502	31660	34706
5	1.37653	40501	43258	45931	48524	51041
6	1.53483	55868	58184	60440	62639	64784
7	1.66877	68920	70917	72869	74778	76646
8	1.78474	80265	82019	83739	85426	87080
9	1.88703	90297	91862	93399	94909	96394
10	1.97854	99289				
	2.		00701	02091	03458	04805
11	2.06131	07437	08723	09991	11240	12472
12	2.13687	14885	16066	17232	18382	19517
13	2.20638	21744	22836	23915	24980	26033
14	2.27073	28100	29116	30120	31112	32093
15	2.33063	34023	34972	35910	36839	37758
16	2.38667	39567	40457	41339	42211	43075
17	2.43930	44777	45616	46447	47270	48085
18	2.48893	49693	50486	51271	52050	52821
19	2.53586	54344	55096	55841	56580	57313
20	2.58039	58759	59474	60182	60885	61582
21	2.62274	62960	63641	64316	64987	65652
22	2.66312	66967	67617	68262	68903	69538
23	2.70170	70796	71418	72036	72649	73258
24	2.73863	74464	75060	75652	76241	76825
25	2.77405	77982	78555	79124	79689	80251
26	2.80809	81363	81914	82461	83005	83546
27	2.84083	84617	85148	85675	86199	86720
28	2.87238	87753	88265	88773	89279	89782
29	2.90282	90779	91273	91765	92254	92739
30	2.93223	93703	94181	94656	95129	95599
31	2.96067	96532	96994	97454	97912	98367
32	2.98820	99270	99719			
	3.			00164	00608	01049
33	3.01488	01925	02360	02792	03222	03651
34	3.04077	04501	04922	05342	05760	06176
35	3.06590	07001	07411	07819	08225	08629
36	3.09032	09432	09831	10227	10622	11015
37	3.11406	11796	12184	12570	12954	13337
38	3.13718	14097	14475	14850	15225	15597
39	3.15969	16338	16706	17072	17437	17800
40	3.18162	18522	18881	19238	19594	19949
41	3.20301	20653	21003	21351	21699	22044
42	3.22389	22732	23073	23414	23753	24090
43	3.24427	24762	25095	25428	25759	26089
44	3.26418	26745	27071	27396	27720	28042
45	3.28363	28683	29002	29320	29637	29952
46	3.30266	30579	30891	31202	31512	31820
47	3.32128	32434	32739	33044	33347	33649
48	3.33950	34250	34549	34847	35144	35439
49	3.35734	36028	36321	36613	36903	37193
50	3.37482	37770	38057	38343	38628	38912
51	3.39195	39477	39759	40039	40319	40597
52	3.40875	41152	41427	41702	41976	42250
53	3.42522	42794	43064	43334	43603	43871
54	3.44138	44405	44670	44935	45199	45462
55	3.45724	45986	46247	46507	46766	47024
56	3.47282	47539	47795	48050	48305	48558
57	3.48811	49064	49315	49566	49816	50066
58	3.50314	50562	50809	51056	51301	51547
59	3.51791	52035	52278	52520	52761	53002

1 HOUR.

M	0″	10″	20″	30″	40″	50″
0	3.53243	53482	53721	53959	54197	54434
1	3.54670	54905	55140	55375	55608	55841
2	3.56074	56306	56537	56767	56997	57226
3	3.57455	57683	57910	58137	58363	58589
4	3.58814	59038	59262	59486	59708	59930
5	3.60152	60373	60593	60813	61032	61251
6	3.61469	61686	61903	62120	62336	62551
7	3.62766	62980	63194	63407	63620	63832
8	3.64043	64254	64465	64675	64885	65094
9	3.65302	65510	65717	65924	66131	66337
10	3.66542	66747	66952	67156	67359	67562
11	3.67765	67967	68168	68369	68570	68770
12	3.68969	69169	69367	69566	69763	69961
13	3.70158	70354	70550	70745	70940	71135
14	3.71329	71523	71716	71909	72101	72293
15	3.72485	72676	72867	73057	73247	73436
16	3.73625	73813	74001	74189	74376	74563
17	3.74750	74936	75121	75307	75491	75676
18	3.75860	76043	76227	76409	76592	76774
19	3.76955	77137	77318	77498	77678	77858
20	3.78037	78216	78395	78573	78750	78928
21	3.79105	79282	79458	79634	79809	79985
22	3.80159	80334	80508	80682	80855	81028
23	3.81201	81373	81545	81717	81888	82059
24	3.62230	82400	82570	82739	32908	83077
25	3.83246	83414	83582	83749	83917	84083
26	3.84250	84416	84582	84743	64913	85078
27	3.85242	85406	85570	85734	85897	86060
28	3.86223	86385	86547	86709	86870	87031
29	3.87192	87352	87513	87672	87832	87991
30	3.88150	88309	88467	88625	88783	88940
31	3.89097	89254	89411	89567	89723	89879
32	3.90034	90189	90344	90498	90653	90807
33	3.90960	91114	91267	91420	91572	91724
34	3.91876	92028	92179	92331	92482	92632
35	3.92782	92933	93082	93232	93381	93530
36	3.93679	93827	93975	94123	94271	94418
37	3.94566	94712	94859	95005	95152	95297
38	3.95443	95588	95733	95878	96023	96167
39	3.96311	96455	96599	96742	96885	97028
40	3.97170	97313	97455	97597	97738	97880
41	3.98021	98162	98302	98443	98583	98723
42	3.98862	99002	99141	99280	99419	99557
43	3.99696	99834	99972			
	4.			00109	00247	00384
44	4.00521	00657	00794	00930	01066	01202
45	4.01337	01473	01608	01743	01877	02012
46	4.02146	02280	02414	02547	02681	02814
47	4.02947	03080	03212	03344	03477	03608
48	4.03740	03871	04003	04134	04265	04395
49	4.04526	04656	04786	04916	05045	05175
50	4.05304	05433	05561	05690	05818	05946
51	4.06074	06202	06330	06457	06584	06711
52	4.06838	06965	07091	07217	07343	07469
53	4.07595	07720	07845	07970	08095	08220
54	4.08344	08468	08592	08716	08840	08964
55	4.09087	09210	09333	09456	09578	09701
56	4.09823	09945	10067	10188	10310	10431
57	4.10552	10673	10794	10915	11035	11155
58	4.11275	11395	11515	11634	11754	11873
59	4.11992	12111	12229	12348	12466	12584

TABLE XXIII.

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

2 HOURS.

M	0″	10″	20″	30″	40″	50″
0	4.12702	12820	12938	13055	13172	13289
1	4.13406	13523	13640	13756	13872	13989
2	4.14104	14220	14336	14451	14567	14682
3	4.14797	14911	15026	15140	15255	15369
4	4.15483	15597	15710	15824	15937	16050
5	4.16163	16276	16389	16501	16614	16726
6	4.16833	16950	17062	17173	17285	17396
7	4.17507	17618	17729	17840	17950	18060
8	4.18171	18281	18391	18500	18610	18719
9	4.18829	18938	19047	19156	19265	19373
10	4.19482	19590	19698	19806	19914	20022
11	4.20129	20236	20344	20451	20558	20665
12	4.20771	20878	20984	21091	21197	21303
13	4.21409	21514	21620	21725	21831	21936
14	4.22041	22146	22250	22355	22459	22564
15	4.22668	22772	22876	22980	23083	23187
16	4.23290	23393	23496	23599	23702	23805
17	4.23907	24010	24112	24214	24316	24418
18	4.24520	24622	24723	24825	24926	25027
19	4.25128	25229	25330	25430	25531	25631
20	4.25731	25831	25931	26031	26131	26231
21	4.26330	26429	26529	26628	26727	26826
22	4.26924	27023	27121	27220	27318	27416
23	4.27514	27612	27710	27807	27905	28002
24	4.28099	28197	28294	28391	28487	28584
25	4.28681	28777	28873	28969	29066	29161
26	4.29257	29353	29449	29544	29639	29735
27	4.29830	29925	30020	30115	30209	30304
28	4.30398	30493	30587	30681	30775	30869
29	4.30963	31056	31150	31243	31337	31430
30	4.31523	31616	31709	31801	31894	31987
31	4.32079	32171	32264	32356	32448	32540
32	4.32631	32723	32815	32906	32997	33089
33	4.33180	33271	33362	33453	33543	33634
34	4.33724	33815	33905	33995	34085	34175
35	4.34265	34355	34444	34534	34623	34713
36	4.34802	34891	34980	35069	35158	35247
37	4.35335	35424	35512	35601	35689	35777
38	4.35865	35953	36041	36128	36216	36304
39	4.36391	36478	36565	36653	36740	36827
40	4.36913	37000	37087	37173	37260	37346
41	4.37432	37518	37604	37690	37776	37862
42	4.37948	38033	38119	38204	38289	38374
43	4.38460	38545	38629	38714	38799	38884
44	4.38968	39052	39137	39221	39305	39389
45	4.39473	39557	39641	39725	39808	39892
46	4.39975	40058	40142	40225	40308	40391
47	4.40474	40556	40639	40722	40804	40887
48	4.40969	41051	41133	41215	41297	41379
49	4.41461	41543	41624	41706	41787	41868
50	4.41950	42031	42112	42193	42274	42355
51	4.42435	42516	42597	42677	42758	42838
52	4.42918	42998	43078	43158	43238	43318
53	4.43398	43477	43557	43636	43716	43795
54	4.43874	43953	44032	44111	44190	44269
55	4.44348	44426	44505	44583	44662	44740
56	4.44818	44896	44974	45052	45130	45208
57	4.45286	45363	45441	45518	45596	45673
58	4.45750	45827	45905	45982	46058	46135
59	4.46212	46289	46365	46442	46518	4659[illegible]

3 HOURS.

M	0″	10″	20″	30″	40″	50″
0	4.46671	46747	46823	46899	46975	47051
1	4.47127	47203	47278	47354	47430	47505
2	4.47580	47656	47731	47806	47881	47956
3	4.48031	48106	48180	48255	48330	48404
4	4.48479	48553	48627	48701	48776	48850
5	4.48924	48998	49071	49145	49219	49293
6	4.49366	49440	49513	49586	49660	49733
7	4.49806	49879	49952	50025	50098	50170
8	4.50243	50316	50388	50461	50533	50605
9	4.50677	50750	50822	50894	50966	51038
10	4.51109	51181	51253	51324	51396	51467
11	4.51539	51610	51681	51753	51824	51895
12	4.51966	52037	52107	52178	52249	52319
13	4.52390	52461	52531	52601	52672	52742
14	4.52812	52882	52952	53022	53092	53162
15	4.53231	53301	53371	53440	53510	53579
16	4.53648	53718	53787	53856	53925	53994
17	4.54063	54132	54201	54269	54338	54407
18	4.54475	54544	54612	54680	54749	54817
19	4.54885	54953	55021	55089	55157	55225
20	4.55293	55360	55428	55496	55563	55630
21	4.55698	55765	55832	55900	55967	56034
22	4.56101	56168	56235	56301	56368	56435
23	4.56501	56568	56635	56701	56767	56834
24	4.56900	56966	57032	57098	57164	57230
25	4.57296	57362	57428	57493	57559	57625
26	4.57690	57755	57821	57886	57951	58017
27	4.58082	58147	58212	58277	58342	58407
28	4.58471	58536	58601	58665	58730	58794
29	4.58859	58923	58988	59052	59116	59180
30	4.59244	59308	59372	59436	59500	59564
31	4.59627	59691	59755	59818	59882	59945
32	4.60008	60072	60135	60198	60261	60324
33	4.60388	60450	60513	60576	60639	60701
34	4.60765	60827	60890	60952	61015	61077
35	4.61139	61202	61264	61326	61388	61450
36	4.61512	61574	61636	61698	61760	61822
37	4.61883	61945	62006	62068	62129	62191
38	4.62252	62313	62375	62436	62497	62558
39	4.62619	62680	62741	62802	62863	62923
40	4.62984	63045	63105	63166	63226	63287
41	4.63347	63407	63468	63528	63588	63648
42	4.63708	63768	63828	63888	63948	64008
43	4.64068	64127	64187	64246	64306	64365
44	4.64425	64484	64544	64603	64662	64721
45	4.64780	64839	64898	64957	65016	65075
46	4.65134	65193	65251	65310	65369	65427
47	4.65486	65544	65603	65661	65719	65777
48	4.65836	65894	65952	66010	66068	66126
49	4.66184	66242	66299	66357	66415	66472
50	4.66530	66588	66645	66702	66760	66817
51	4.66875	66932	66989	67046	67103	67160
52	4.67217	67274	67331	67388	67445	67502
53	4.67558	67615	67672	67728	6778[illegible]	67841
54	4.67897	67954	68010	68066	68123	68179
55	4.68235	68291	68347	68403	68459	68515
56	4.68571	68627	68682	68738	68794	68849
57	4.68905	68960	69016	69071	69127	69182
58	4.69237	69292	69348	69403	69458	69513
59	4.69568	6962[illegible]	69678	69733	69788	69842

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

4 HOURS.

M	0″	10″	20″	30″	40″	50″
0	4.69897	69952	70006	70061	70115	70170
1	4.70224	70279	70333	70387	70442	70496
2	4.70550	70604	70658	70712	70766	70820
3	4.70874	70928	70982	71036	71089	71143
4	4.71197	71250	71304	71357	71411	71464
5	4.71518	71571	71624	71678	71731	71784
6	4.71837	71890	71943	71996	72049	72102
7	4.72155	72208	72260	72313	72366	72418
8	4.72471	72523	72576	72628	72681	72733
9	4.72785	72838	72890	72942	72994	73046
10	4.73099	73151	73203	73254	73306	73358
11	4.73410	73462	73514	73565	73617	73668
12	4.73720	73772	73823	73874	73926	73977
13	4.74028	74080	74131	74182	74233	74284
14	4.74335	74386	74437	74488	74539	74590
15	4.74641	74692	74742	74793	74844	74894
16	4.74945	74995	75046	75096	75147	75197
17	4.75247	75298	75348	75398	75448	75498
18	4.75549	75599	75649	75699	75748	75798
19	4.75848	75898	75948	75997	76047	76097
20	4.76146	76196	76245	76295	76344	76394
21	4.76443	76492	76542	76591	76640	76689
22	4.76738	76787	76836	76885	76934	76983
23	4.77032	77081	77130	77179	77227	77276
24	4.77325	77373	77422	77470	77519	77567
25	4.77616	77664	77713	77761	77809	77857
26	4.77906	77954	78002	78050	78098	78146
27	4.78194	78242	78290	78338	78385	78433
28	4.78481	78529	78576	78624	78671	78719
29	4.78767	78814	78861	78909	78956	79004
30	4.79051	79098	79145	79192	79240	79287
31	4.79334	79381	79428	79475	79522	79568
32	4.79615	79662	79709	79756	79802	79849
33	4.79896	79942	79989	80035	80082	80128
34	4.80175	80221	80267	80314	80360	80406
35	4.80452	80498	80545	80591	80637	80683
36	4.80729	80775	80820	80866	80912	80958
37	4.81004	81049	81095	81141	81186	81232
38	4.81277	81323	81368	81414	81459	81505
39	4.81550	81595	81641	81686	81731	81776
40	4.81821	81866	81911	81956	82001	82046
41	4.82091	82136	82181	82226	82271	82315
42	4.82360	82405	82449	82494	82538	82583
43	4.82628	82672	82716	82761	82805	82850
44	4.82894	82938	82982	83026	83071	83115
45	4.83159	83203	83247	83291	83335	83379
46	4.83423	83467	83510	83554	83598	83642
47	4.83685	83729	83773	83816	83860	83903
48	4.83947	83990	84034	84077	84120	84164
49	4.84207	84250	84293	84337	84380	84423
50	4.84466	84509	84552	84595	84638	84681
51	4.84724	84767	84810	84852	84895	84938
52	4.84981	85023	85066	85108	85151	85194
53	4.85236	85278	85321	85363	85406	85448
54	4.85490	85533	85575	85617	85659	85701
55	4.85744	85786	85828	85870	85912	85954
56	4.85996	86038	86079	86121	86163	86205
57	4.86247	86288	86330	86372	86413	86455
58	4.86496	86538	86579	86621	86662	86704
59	4.86745	86786	86828	86869	86910	86951

5 HOURS.

M	0″	10″	20″	30″	40″	50″
0	4.86992	87034	87075	87116	87157	87198
1	4.87239	87280	87321	87362	87402	87443
2	4.87484	87525	87566	87606	87647	87688
3	4.87728	87769	87809	87850	87890	87931
4	4.87971	88012	88052	88093	88133	88173
5	4.88213	88254	88294	88334	88374	88414
6	4.88454	88494	88534	88574	88614	88654
7	4.88694	88734	88774	88814	88853	88893
8	4.88933	88973	89012	89052	89091	89131
9	4.89171	89210	89250	89289	89328	89368
10	4.89407	89447	89486	89525	89564	89604
11	4.89643	89682	89721	89760	89799	89838
12	4.89877	89916	89955	89994	90033	90072
13	4.90111	90150	90188	90227	90266	90305
14	4.90343	90382	90421	90459	90498	90536
15	4.90575	90613	90652	90690	90728	90767
16	4.90805	90843	90882	90920	90958	90996
17	4.91034	91073	91111	91149	91187	91225
18	4.91263	91301	91339	91377	91414	91452
19	4.91490	91528	91566	91603	91641	91679
20	4.91716	91754	91792	91829	91867	91904
21	4.91942	91979	92017	92054	92092	92129
22	4.92166	92203	92241	92278	92315	92352
23	4.92390	92427	92464	92501	92538	92575
24	4.92612	92649	92686	92723	92760	92796
25	4.92833	92870	92907	92944	92980	93017
26	4.93054	93090	93127	93164	93200	93237
27	4.93273	93310	93346	93382	93419	93455
28	4.93492	93528	93564	93600	93637	93673
29	4.93709	93745	93781	93817	93854	93890
30	4.93926	93962	93998	94034	94069	94105
31	4.94141	94177	94213	94249	94284	94320
32	4.94356	94392	94427	94463	94498	94534
33	4.94570	94605	94641	94676	94712	94747
34	4.94782	94818	94853	94888	94924	94959
35	4.94994	95029	95065	95100	95135	95170
36	4.95205	95240	95275	95310	95345	95380
37	4.95415	95450	95485	95520	95555	95589
38	4.95624	95659	95694	95728	95763	95798
39	4.95832	95867	95902	95936	95971	96005
40	4.96040	96074	96109	96143	96177	96212
41	4.96246	96280	96315	96349	96383	96417
42	4.96451	96486	96520	96554	96588	96622
43	4.96656	96690	96724	96758	96792	96826
44	4.96860	96894	96927	96961	96995	97029
45	4.97062	97096	97130	97163	97197	97231
46	4.97264	97298	97331	97365	97398	97432
47	4.97465	97499	97532	97565	97599	97632
48	4.97665	97699	97732	97765	97798	97832
49	4.97865	97898	97931	97964	97997	98030
50	4.98063	98096	98129	98162	98195	98228
51	4.98261	98293	98326	98359	98392	98425
52	4.98457	98490	98523	98555	98588	98620
53	4.98653	98686	98718	98751	98783	98816
54	4.98848	98880	98913	98945	98977	99010
55	4.99042	99074	99107	99139	99171	99203
56	4.99235	99267	99300	99332	99364	99396
57	4.99428	99460	99492	99524	99556	99587
58	4.99619	99651	99683	99715	99747	99778
59	4.99810	99842	99873	99905	99937	99968

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

6 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.00000	00032	00063	00095	00126	00158
1	5.00189	00221	00252	00283	00315	00346
2	5.00377	00409	00440	00471	00502	00534
3	5.00565	00596	00627	00658	00689	00720
4	5.00751	00782	00813	00844	00875	00906
5	5.00937	00968	00999	01030	01061	01091
6	5.01122	01153	01184	01214	01245	01276
7	5.01306	01337	01368	01398	01429	01459
8	5.01490	01520	01551	01581	01612	01642
9	5.01672	01703	01733	01763	01794	01824
10	5.01854	01884	01915	01945	01975	02005
11	5.02035	02065	02095	02125	02155	02185
12	5.02215	02245	02275	02305	02335	02365
13	5.02395	02425	02455	02484	02514	02544
14	5.02574	02603	02633	02663	02692	02722
15	5.02751	02781	02811	02840	02870	02899
16	5.02928	02958	02987	03017	03046	03075
17	5.03105	03134	03163	03193	03222	03251
18	5.03280	03310	03339	03368	03397	03426
19	5.03455	03484	03513	03542	03571	03600
20	5.03629	03658	03687	03716	03745	03774
21	5.03802	03831	03860	03889	03918	03946
22	5.03975	04004	04032	04061	04090	04118
23	5.04147	04175	04204	04232	04261	04289
24	5.04318	04346	04375	04403	04431	04460
25	5.04488	04516	04545	04573	04601	04629
26	5.04657	04686	04714	04742	04770	04798
27	5.04826	04854	04882	04910	04938	04966
28	5.04994	05022	05050	05078	05106	05134
29	5.05162	05189	05217	05245	05273	05300
30	5.05328	05356	05383	05411	05439	05466
31	5.05494	05521	05549	05577	05604	05632
32	5.05659	05686	05714	05741	05769	05796
33	5.05823	05851	05878	05905	05933	05960
34	5.05987	06014	06041	06069	06096	06123
35	5.06150	06177	06204	06231	06258	06285
36	5.06312	06339	06366	06393	06420	06447
37	5.06474	06500	06527	06554	06581	06608
38	5.06634	06661	06688	06714	06741	06768
39	5.06794	06821	06848	06874	06901	06927
40	5.06954	06980	07007	07033	07060	07086
41	5.07112	07139	07165	07192	07218	07244
42	5.07270	07297	07323	07349	07375	07401
43	5.07428	07454	07480	07506	07532	07558
44	5.07584	07610	07636	07662	07688	07714
45	5.07740	07766	07792	07818	07844	07869
46	5.07895	07921	07947	07973	07998	08024
47	5.08050	08075	08101	08127	08152	08178
48	5.08204	08229	08255	08280	08306	08331
49	5.08357	08382	08408	08433	08458	08484
50	5.08509	08534	08560	08585	08610	08636
51	5.08661	08686	08711	08736	08762	08787
52	5.08812	08837	08862	08887	08912	08937
53	5.08962	08987	09012	09037	09062	09087
54	5.09112	09137	09162	09187	09211	09236
55	5.09261	09286	09311	09335	09360	09385
56	5.09409	09434	09459	09483	09508	09533
57	5.09557	09582	09606	09631	09655	09680
58	5.09704	09729	09753	09777	09802	09826
59	5.09851	09875	09899	09924	09948	09972

7 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.09996	10021	10045	10069	10093	10117
1	5.10141	10166	10190	10214	10238	10262
2	5.10286	10310	10334	10358	10382	10406
3	5.10430	10454	10477	10501	10525	10549
4	5.10573	10597	10620	10644	10668	10691
5	5.10715	10739	10763	10786	10810	10833
6	5.10857	10881	10904	10928	10951	10975
7	5.10998	11022	11045	11069	11092	11115
8	5.11139	11162	11185	11209	11232	11255
9	5.11279	11302	11325	11348	11372	11395
10	5.11418	11441	11464	11487	11510	11533
11	5.11557	11580	11603	11626	11649	11672
12	5.11695	11717	11740	11763	11786	11809
13	5.11832	11855	11878	11900	11923	11946
14	5.11969	11991	12014	12037	12059	12082
15	5.12105	12127	12150	12173	12195	12218
16	5.12240	12263	12285	12308	12330	12353
17	5.12375	12397	12420	12442	12465	12487
18	5.12509	12532	12554	12576	12598	12621
19	5.12643	12665	12687	12709	12732	12754
20	5.12776	12798	12820	12842	12864	12886
21	5.12908	12930	12952	12974	12996	13018
22	5.13040	13062	13084	13106	13128	13149
23	5.13171	13193	13215	13237	13258	13280
24	5.13302	13323	13345	13367	13388	13410
25	5.13432	13453	13475	13496	13518	13539
26	5.13561	13582	13604	13625	13647	13668
27	5.13690	13711	13732	13754	13775	13797
28	5.13818	13839	13860	13882	13903	13924
29	5.13945	13967	13988	14009	14030	14051
30	5.14072	14093	14114	14136	14157	14178
31	5.14199	14220	14241	14262	14282	14303
32	5.14324	14345	14366	14387	14408	14429
33	5.14449	14470	14491	14512	14533	14553
34	5.14574	14595	14615	14636	14657	14677
35	5.14698	14719	14739	14760	14780	14801
36	5.14821	14842	14862	14883	14903	14924
37	5.14944	14964	14985	15005	15026	15046
38	5.15066	15087	15107	15127	15147	15168
39	5.15188	15208	15228	15248	15269	15289
40	5.15309	15329	15349	15369	15389	15409
41	5.15429	15449	15469	15489	15509	15529
42	5.15549	15569	15589	15609	15629	15649
43	5.15668	15688	15708	15728	15748	15767
44	5.15787	15807	15827	15846	15866	15886
45	5.15905	15925	15944	15964	15984	16003
46	5.16023	16042	16062	16081	16101	16120
47	5.16140	16159	16179	16198	16217	16237
48	5.16256	16276	16295	16314	16333	16353
49	5.16372	16391	16410	16430	16449	16468
50	5.16487	16506	16526	16545	16564	16583
51	5.16602	16621	16640	16659	16678	16697
52	5.16716	16735	16754	16773	16792	16811
53	5.16830	16849	16867	16886	16905	16924
54	5.16943	16961	16980	16999	17018	17036
55	5.17055	17074	17093	17111	17130	17148
56	5.17167	17186	17204	17223	17241	17260
57	5.17278	17297	17315	17334	17352	17371
58	5.17389	17408	17426	17444	17463	17481
59	5.17499	17518	17536	17554	17573	17591

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

8 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.17609	17627	17646	17664	17682	17700
1	5.17718	17736	17755	17773	17791	17809
2	5.17827	17845	17863	17881	17899	17917
3	5.17935	17953	17971	17989	18007	18024
4	5.18042	18060	18078	18096	18114	18132
5	5.18149	18167	18185	18203	18220	18238
6	5.18256	18273	18291	18309	18326	18344
7	5.18362	18379	18397	18414	18432	18449
8	5.18467	18484	18502	18519	18537	18554
9	5.18572	18589	18606	18624	18641	18659
10	5.18676	18693	18710	18728	18745	18762
11	5.18780	18797	18814	18831	18848	18866
12	5.18883	18900	18917	18934	18951	18968
13	5.18985	19002	19019	19036	19053	19070
14	5.19087	19104	19121	19138	19155	19172
15	5.19189	19206	19223	19240	19256	19273
16	5.19290	19307	19324	19340	19357	19374
17	5.19390	19407	19424	19441	19457	19474
18	5.19490	19507	19524	19540	19557	19573
19	5.19590	19606	19623	19639	19656	19672
20	5.19689	19705	19722	19738	19754	19771
21	5.19787	19804	19820	19836	19852	19869
22	5.19835	19901	19918	19934	19950	19966
23	5.19982	19999	20015	20031	20047	20063
24	5.20079	20095	20111	20127	20143	20159
25	5.20175	20191	20207	20223	20239	20255
26	5.20271	20287	20303	20319	20335	20351
27	5.20366	20382	20398	20414	20430	20445
28	5.20461	20477	20493	20508	20524	20540
29	5.20555	20571	20587	20602	20618	20634
30	5.20649	20665	20680	20696	20711	20727
31	5.20742	20758	20773	20789	20804	20820
32	5.20835	20850	20866	20881	20897	20912
33	5.20927	20943	20958	20973	20938	21004
34	5.21019	21034	21049	21065	21080	21095
35	5.21110	21125	21140	21155	21170	21186
36	5.21201	21216	21231	21246	21261	21276
37	5.21291	21306	21321	21336	21351	21366
38	5.21380	21395	21410	21425	21440	21455
39	5.21470	21484	21499	21514	21529	21543
40	5.21558	21573	21588	21602	21617	21632
41	5.21646	21661	21676	21690	21705	21719
42	5.21734	21748	21763	21777	21792	21806
43	5.21821	21835	21850	21864	21879	21893
44	5.21908	21922	21936	21951	21965	21979
45	5.21994	22008	22022	22037	22051	22065
46	5.22079	22094	22108	22122	22136	22150
47	5.22164	22179	22193	22207	22221	22235
48	5.22249	22263	22277	22291	22305	22319
49	5.22333	22347	22361	22375	22389	22403
50	5.22417	22431	22445	22458	22472	22486
51	5.22500	22514	22528	22541	22555	22569
52	5.22583	22596	22610	22624	22637	22651
53	5.22665	22678	22692	22706	22719	22733
54	5.22746	22760	22773	22787	22801	22814
55	5.22828	22841	22854	22868	22881	22895
56	5.22908	22922	22935	22948	22962	22975
57	5.22988	23002	23015	23028	23042	23055
58	5.23068	23081	23095	23108	23121	23134
59	5.23147	23160	23174	23187	23200	23213

9 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.23226	23239	23252	23265	23278	23291
1	5.23304	23317	23330	23343	23356	23369
2	5.23382	23395	23408	23421	23434	23447
3	5.23459	23472	23485	23498	23511	23523
4	5.23536	23549	23562	23574	23587	23600
5	5.23612	23625	23638	23650	23663	23676
6	5.23688	23701	23714	23726	23739	23751
7	5.23764	23776	23789	23801	23814	23826
8	5.23839	23851	23863	23876	23888	23901
9	5.23913	23925	23938	23950	23962	23975
10	5.23987	23999	24011	24024	24036	24048
11	5.24060	24073	24085	24097	24109	24121
12	5.24133	24145	24158	24170	24182	24194
13	5.24206	24218	24230	24242	24254	24266
14	5.24278	24290	24302	24314	24326	24338
15	5.24349	24361	24373	24385	24397	24409
16	5.24421	24432	24444	24456	24468	24479
17	5.24491	24503	24515	24526	24538	24550
18	5.24561	24573	24585	24596	24608	24619
19	5.24631	24643	24654	24666	24677	24689
20	5.24700	24712	24723	24735	24746	24757
21	5.24769	24780	24792	24803	24814	24826
22	5.24837	24849	24860	24871	24882	24894
23	5.24905	24916	24927	24939	24950	24961
24	5.24972	24983	24995	25006	25017	25028
25	5.25039	25050	25061	25072	25084	25095
26	5.25106	25117	25128	25139	25150	25161
27	5.25172	25182	25193	25204	25215	25226
28	5.25237	25248	25259	25270	25280	25291
29	5.25302	25313	25324	25334	25345	25356
30	5.25367	25377	25388	25399	25409	25420
31	5.25431	25441	25452	25463	25473	25484
32	5.25494	25505	25515	25526	25536	25547
33	5.25557	25568	25578	25589	25599	25610
34	5.25620	25631	25641	25651	25662	25672
35	5.25682	25693	25703	25713	25724	25734
36	5.25744	25755	25765	25775	25785	25795
37	5.25806	25816	25826	25836	25846	25856
38	5.25866	25877	25887	25897	25907	25917
39	5.25927	25937	25947	25957	25967	25977
40	5.25987	25997	26007	26017	26027	26037
41	5.26046	26056	26066	26076	26086	26096
42	5.26105	26115	26125	26135	26145	26154
43	5.26164	26174	26184	26193	26203	26213
44	5.26222	26232	26242	26251	26261	26270
45	5.26280	26290	26299	26309	26318	26328
46	5.26337	26347	26356	26366	26375	26385
47	5.26394	26403	26413	26422	26432	26441
48	5.26450	26460	26469	26478	26488	26497
49	5.26506	26516	26525	26534	26543	26553
50	5.26562	26571	26580	26589	26598	26608
51	5.26617	26626	26635	26644	26653	26662
52	5.26671	26680	26689	26698	26707	26716
53	5.26725	26734	26743	26752	26761	26770
54	5.26779	26788	26797	26806	26815	26823
55	5.26832	26841	26850	26859	26868	26876
56	5.26885	26894	26903	26911	26920	26929
57	5.26937	26946	26955	26963	26972	26981
58	5.26989	26998	27007	27015	27024	27032
59	5.27041	27049	27058	27066	27075	27083

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

M	6 HOURS. 0″	10″	20″	30″	40″	50″	M	7 HOURS. 0″	10″	20″	30″	40″	50″
0	5.00000	00032	00063	00095	00126	00158	0	5.09996	10021	10045	10069	10093	10117
1	5.00189	00221	00252	00283	00315	00346	1	5.10141	10166	10190	10214	10238	10262
2	5.00377	00409	00440	00471	00502	00534	2	5.10286	10310	10334	10358	10382	10406
3	5.00565	00596	00627	00658	00689	00720	3	5.10430	10454	10477	10501	10525	10549
4	5.00751	00782	00813	00844	00875	00906	4	5.10573	10597	10620	10644	10668	10691
5	5.00937	00968	00999	01030	01061	01091	5	5.10715	10739	10763	10786	10810	10833
6	5.01122	01153	01184	01214	01245	01276	6	5.10857	10881	10904	10928	10951	10975
7	5.01306	01337	01368	01398	01429	01459	7	5.10998	11022	11045	11069	11092	11115
8	5.01490	01520	01551	01581	01612	01642	8	5.11139	11162	11185	11209	11232	11255
9	5.01672	01703	01733	01763	01794	01824	9	5.11279	11302	11325	11348	11372	11395
10	5.01854	01884	01915	01945	01975	02005	10	5.11418	11441	11464	11487	11510	11533
11	5.02035	02065	02095	02125	02155	02185	11	5.11557	11580	11603	11626	11649	11672
12	5.02215	02245	02275	02305	02335	02365	12	5.11695	11717	11740	11763	11786	11809
13	5.02395	02425	02455	02484	02514	02544	13	5.11832	11855	11878	11900	11923	11946
14	5.02574	02603	02633	02663	02692	02722	14	5.11969	11991	12014	12037	12059	12082
15	5.02751	02781	02811	02840	02870	02899	15	5.12105	12127	12150	12173	12195	12218
16	5.02928	02958	02987	03017	03046	03075	16	5.12240	12263	12285	12308	12330	12353
17	5.03105	03134	03163	03193	03222	03251	17	5.12375	12397	12420	12442	12465	12487
18	5.03280	03310	03339	03368	03397	03426	18	5.12509	12532	12554	12576	12598	12621
19	5.03455	03484	03513	03542	03571	03600	19	5.12643	12665	12687	12709	12732	12754
20	5.03629	03658	03687	03716	03745	03774	20	5.12776	12798	12820	12842	12864	12886
21	5.03802	03831	03860	03889	03918	03946	21	5.12908	12930	12952	12974	12996	13018
22	5.03975	04004	04032	04061	04090	04118	22	5.13040	13062	13084	13106	13128	13149
23	5.04147	04175	04204	04232	04261	04289	23	5.13171	13193	13215	13237	13258	13280
24	5.04318	04346	04375	04403	04431	04460	24	5.13302	13323	13345	13367	13388	13410
25	5.04488	04516	04545	04573	04601	04629	25	5.13432	13453	13475	13496	13518	13539
26	5.04657	04686	04714	04742	04770	04798	26	5.13561	13582	13604	13625	13647	13668
27	5.04826	04854	04882	04910	04938	04966	27	5.13690	13711	13732	13754	13775	13797
28	5.04994	05022	05050	05078	05106	05134	28	5.13818	13839	13860	13882	13903	13924
29	5.05162	05189	05217	05245	05273	05300	29	5.13945	13967	13988	14009	14030	14051
30	5.05328	05356	05383	05411	05439	05466	30	5.14072	14093	14114	14136	14157	14178
31	5.05494	05521	05549	05577	05604	05632	31	5.14199	14220	14241	14262	14282	14303
32	5.05659	05686	05714	05741	05769	05796	32	5.14324	14345	14366	14387	14408	14429
33	5.05823	05851	05878	05905	05933	05960	33	5.14449	14470	14491	14512	14533	14553
34	5.05987	06014	06041	06069	06096	06123	34	5.14574	14595	14615	14636	14657	14677
35	5.06150	06177	06204	06231	06258	06285	35	5.14698	14719	14739	14760	14780	14801
36	5.06312	06339	06366	06393	06420	06447	36	5.14821	14842	14862	14883	14903	14924
37	5.06474	06500	06527	06554	06581	06608	37	5.14944	14964	14985	15005	15026	15046
38	5.06634	06661	06688	06714	06741	06768	38	5.15066	15087	15107	15127	15147	15168
39	5.06794	06821	06848	06874	06901	06927	39	5.15188	15208	15228	15248	15269	15289
40	5.06954	06980	07007	07033	07060	07086	40	5.15309	15329	15349	15369	15389	15409
41	5.07112	07139	07165	07192	07218	07244	41	5.15429	15449	15469	15489	15509	15529
42	5.07270	07297	07323	07349	07375	07401	42	5.15549	15569	15589	15609	15629	15649
43	5.07428	07454	07480	07506	07532	07558	43	5.15668	15688	15708	15728	15748	15767
44	5.07584	07610	07636	07662	07688	07714	44	5.15787	15807	15827	15846	15866	15886
45	5.07740	07766	07792	07818	07844	07869	45	5.15905	15925	15944	15964	15984	16003
46	5.07895	07921	07947	07973	07998	08024	46	5.16023	16042	16062	16081	16101	16120
47	5.08050	08075	08101	08127	08152	08178	47	5.16140	16159	16179	16198	16217	16237
48	5.08204	08229	08255	08280	08306	08331	48	5.16256	16276	16295	16314	16333	16353
49	5.08357	08382	08408	08433	08458	08484	49	5.16372	16391	16410	16430	16449	16468
50	5.08509	08534	08560	08585	08610	08636	50	5.16487	16506	16526	16545	16564	16583
51	5.08661	08686	08711	08736	08762	08787	51	5.16602	16621	16640	16659	16678	16697
52	5.08812	08837	08862	08887	08912	08937	52	5.16716	16735	16754	16773	16792	16811
53	5.08962	08987	09012	09037	09062	09087	53	5.16830	16849	16867	16886	16905	16924
54	5.09112	09137	09162	09187	09211	09236	54	5.16943	16961	16980	16999	17018	17036
55	5.09261	09286	09311	09335	09360	09385	55	5.17055	17074	17093	17111	17130	17148
56	5.09409	09434	09459	09483	09508	09533	56	5.17167	17186	17204	17223	17241	17260
57	5.09557	09582	09606	09631	09655	09680	57	5.17278	17297	17315	17334	17352	17371
58	5.09704	09729	09753	09777	09802	09826	58	5.17389	17408	17426	17444	17463	17481
59	5.09851	09875	09899	09924	09948	09972	59	5.17499	17518	17536	17554	17573	17591

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

8 HOURS.						
M	0″	10″	20″	30″	40″	50″
0	5.17609	17627	17646	17664	17682	17700
1	5.17718	17736	17755	17773	17791	17809
2	5.17827	17845	17863	17881	17899	17917
3	5.17935	17953	17971	17989	18007	18024
4	5.18042	18060	18078	18096	18114	18132
5	5.18149	18167	18185	18203	18220	18238
6	5.18256	18273	18291	18309	18326	18344
7	5.18362	18379	18397	18414	18432	18449
8	5.18467	18484	18502	18519	18537	18554
9	5.18572	18589	18606	18624	18641	18659
10	5.18676	18693	18710	18728	18745	18762
11	5.18780	18797	18814	18831	18848	18866
12	5.18883	18900	18917	18934	18951	18968
13	5.18985	19002	19019	19036	19053	19070
14	5.19087	19104	19121	19138	19155	19172
15	5.19189	19206	19223	19240	19256	19273
16	5.19290	19307	19324	19340	19357	19374
17	5.19390	19407	19424	19441	19457	19474
18	5.19490	19507	19524	19540	19557	19573
19	5.19590	19606	19623	19639	19656	19672
20	5.19689	19705	19722	19738	19754	19771
21	5.19787	19804	19820	19836	19852	19869
22	5.19885	19901	19918	19934	19950	19966
23	5.19982	19999	20015	20031	20047	20063
24	5.20079	20095	20111	20127	20143	20159
25	5.20175	20191	20207	20223	20239	20255
26	5.20271	20287	20303	20319	20335	20351
27	5.20366	20382	20398	20414	20430	20445
28	5.20461	20477	20493	20508	20524	20540
29	5.20555	20571	20587	20602	20618	20634
30	5.20649	20665	20680	20696	20711	20727
31	5.20742	20758	20773	20789	20804	20820
32	5.20835	20850	20866	20881	20897	20912
33	5.20927	20943	20958	20973	20988	21004
34	5.21019	21034	21049	21065	21080	21095
35	5.21110	21125	21140	21155	21170	21186
36	5.21201	21216	21231	21246	21261	21276
37	5.21291	21306	21321	21336	21351	21366
38	5.21380	21395	21410	21425	21440	21455
39	5.21470	21484	21499	21514	21529	21543
40	5.21558	21573	21588	21602	21617	21632
41	5.21646	21661	21676	21690	21705	21719
42	5.21734	21748	21763	21777	21792	21806
43	5.21821	21835	21850	21864	21879	21893
44	5.21908	21922	21936	21951	21965	21979
45	5.21994	22008	22022	22037	22051	22065
46	5.22079	22094	22108	22122	22136	22150
47	5.22164	22179	22193	22207	22221	22235
48	5.22249	22263	22277	22291	22305	22319
49	5.22333	22347	22361	22375	22389	22403
50	5.22417	22431	22445	22458	22472	22486
51	5.22500	22514	22528	22541	22555	22569
52	5.22583	22596	22610	22624	22637	22651
53	5.22665	22678	22692	22706	22719	22733
54	5.22746	22760	22773	22787	22801	22814
55	5.22828	22841	22854	22868	22881	22895
56	5.22908	22922	22935	22948	22962	22975
57	5.22988	23002	23015	23028	23042	23055
58	5.23068	23081	23095	23108	23121	23134
59	5.23147	23160	23174	23187	23200	23213

9 HOURS.						
M	0″	10″	20″	30″	40″	50″
0	5.23226	23239	23252	23265	23278	23291
1	5.23304	23317	23330	23343	23356	23369
2	5.23382	23395	23408	23421	23434	23447
3	5.23459	23472	23485	23498	23511	23523
4	5.23536	23549	23562	23574	23587	23600
5	5.23612	23625	23638	23650	23663	23676
6	5.23688	23701	23714	23726	23739	23751
7	5.23764	23776	23789	23801	23814	23826
8	5.23839	23851	23863	23876	23888	23901
9	5.23913	23925	23938	23950	23962	23975
10	5.23987	23999	24011	24024	24036	24048
11	5.24060	24073	24085	24097	24109	24121
12	5.24133	24145	24158	24170	24182	24194
13	5.24206	24218	24230	24242	24254	24266
14	5.24278	24290	24302	24314	24326	24338
15	5.24349	24361	24373	24385	24397	24409
16	5.24421	24432	24444	24456	24468	24479
17	5.24491	24503	24515	24526	24538	24550
18	5.24561	24573	24585	24596	24608	24619
19	5.24631	24643	24654	24666	24677	24689
20	5.24700	24712	24723	24735	24746	24757
21	5.24769	24780	24792	24803	24814	24826
22	5.24837	24849	24860	24871	24882	24894
23	5.24905	24916	24927	24939	24950	24961
24	5.24972	24983	24995	25006	25017	25028
25	5.25039	25050	25061	25072	25084	25095
26	5.25106	25117	25128	25139	25150	25161
27	5.25172	25182	25193	25204	25215	25226
28	5.25237	25248	25259	25270	25280	25291
29	5.25302	25313	25324	25334	25345	25356
30	5.25367	25377	25388	25399	25409	25420
31	5.25431	25441	25452	25463	25473	25484
32	5.25494	25505	25515	25526	25536	25547
33	5.25557	25568	25578	25589	25599	25610
34	5.25620	25631	25641	25651	25662	25672
35	5.25682	25693	25703	25713	25724	25734
36	5.25744	25755	25765	25775	25785	25795
37	5.25806	25816	25826	25836	25846	25856
38	5.25866	25877	25887	25897	25907	25917
39	5.25927	25937	25947	25957	25967	25977
40	5.25987	25997	26007	26017	26027	26037
41	5.26046	26056	26066	26076	26086	26096
42	5.26105	26115	26125	26135	26145	26154
43	5.26164	26174	26184	26193	26203	26213
44	5.26222	26232	26242	26251	26261	26270
45	5.26280	26290	26299	26309	26318	26328
46	5.26337	26347	26356	26366	26375	26385
47	5.26394	26403	26413	26422	26432	26441
48	5.26450	26460	26469	26478	26488	26497
49	5.26506	26516	26525	26534	26543	26553
50	5.26562	26571	26580	26589	26598	26608
51	5.26617	26626	26635	26644	26653	26662
52	5.26671	26680	26689	26698	26707	26716
53	5.26725	26734	26743	26752	26761	26770
54	5.26779	26788	26797	26806	26815	26823
55	5.26832	26841	26850	26859	26868	26876
56	5.26885	26894	26903	26911	26920	26929
57	5.26937	26946	26955	26963	26972	26981
58	5.26989	26998	27007	27015	27024	27032
59	5.27041	27049	27058	27066	27075	27083

TABLE XXIII.

To find the Latitude by two Altitudes of the Sun.

LOG. RISING OR VERSED SINE.

10 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.27092	27100	27109	27117	27126	27134
1	5.27142	27151	27159	27167	27176	27184
2	5.27192	27201	27209	27217	27226	27234
3	5.27242	27250	27259	27267	27275	27283
4	5.27291	27299	27308	27316	27324	27332
5	5.27340	27348	27356	27364	27372	27380
6	5.27388	27396	27404	27412	27420	27428
7	5.27436	27444	27452	27460	27468	27476
8	5.27484	27492	27500	27507	27515	27523
9	5.27531	27539	27546	27554	27562	27570
10	5.27577	27585	27593	27601	27608	27616
11	5.27624	27631	27639	27647	27654	27662
12	5.27669	27677	27684	27692	27700	27707
13	5.27715	27722	27730	27737	27745	27752
14	5.27759	27767	27774	27782	27789	27796
15	5.27804	27811	27819	27826	27833	27840
16	5.27848	27855	27862	27870	27877	27884
17	5.27891	27899	27906	27913	27920	27927
18	5.27934	27942	27949	27956	27963	27970
19	5.27977	27984	27991	27998	28005	28012
20	5.28019	28026	28033	28040	28047	28054
21	5.28061	28068	28075	28082	28089	28096
22	5.28102	28109	28116	28123	28130	28137
23	5.28143	28150	28157	28164	28170	28177
24	5.28184	28191	28197	28204	28211	28217
25	5.28224	28231	28237	28244	28250	28257
26	5.28264	28270	28277	28283	28290	28296
27	5.28303	28309	28316	28322	28329	28335
28	5.28342	28348	28354	28361	28367	28374
29	5.28380	28386	28393	28399	28405	28411
30	5.28418	28424	28430	28437	28443	28449
31	5.28455	28461	28468	28474	28480	28486
32	5.28492	28498	28505	28511	28517	28523
33	5.28529	28535	28541	28547	28553	28559
34	5.28565	28571	28577	28583	28589	28595
35	5.28601	28607	28613	28619	28624	28630
36	5.28636	28642	28648	28654	28660	28665
37	5.28671	28677	28683	28688	28694	28700
38	5.28706	28711	28717	28723	28728	28734
39	5.28740	28745	28751	28757	28762	28768
40	5.28773	28779	28784	28790	28795	28801
41	5.28806	28812	28817	28823	28828	28834
42	5.28839	28845	28850	28855	28861	28866
43	5.28872	28877	28882	28888	28893	28898
44	5.28904	28909	28914	28919	28925	28930
45	5.28935	28940	28945	28951	28956	28961
46	5.28966	28971	28976	28981	28987	28992
47	5.28997	29002	29007	29012	29017	29022
48	5.29027	29032	29037	29042	29047	29052
49	5.29057	29062	29067	29072	29076	29081
50	5.29086	29091	29096	29101	29106	29110
51	5.29115	29120	29125	29129	29134	29139
52	5.29144	29148	29153	29158	29162	29167
53	5.29172	29176	29181	29186	29190	29195
54	5.29199	29204	29209	29213	29218	29222
55	5.29227	29231	29236	29240	29245	29249
56	5.29254	29258	29262	29267	29271	29276
57	5.29280	29284	29289	29293	29297	29302
58	5.29306	29310	29315	29319	29323	29327
59	5.29332	29336	29340	29344	29348	29353

11 HOURS.

M	0″	10″	20″	30″	40″	50″
0	5.29357	29361	29365	29369	29373	29377
1	5.29381	29386	29390	29394	29398	29402
2	5.29406	29410	29414	29418	29422	29426
3	5.29430	29434	29438	29441	29445	29449
4	5.29453	29457	29461	29465	29469	29472
5	5.29476	29480	29484	29488	29491	29495
6	5.29499	29503	29506	29510	29514	29517
7	5.29521	29525	29528	29532	29536	29539
8	5.29543	29546	29550	29554	29557	29561
9	5.29564	29568	29571	29575	29578	29582
10	5.29585	29589	29592	29596	29599	29602
11	5.29606	29609	29612	29616	29619	29623
12	5.29626	29629	29632	29636	29639	29642
13	5.29646	29649	29652	29655	29658	29662
14	5.29665	29668	29671	29674	29677	29681
15	5.29684	29687	29690	29693	29696	29699
16	5.29702	29705	29708	29711	29714	29717
17	5.29720	29723	29726	29729	29732	29735
18	5.29738	29741	29744	29747	29749	29752
19	5.29755	29758	29761	29764	29766	29769
20	5.29772	29775	29777	29780	29783	29786
21	5.29788	29791	29794	29796	29799	29802
22	5.29804	29807	29809	29812	29815	29817
23	5.29820	29822	29825	29827	29830	29832
24	5.29835	29837	29840	29842	29845	29847
25	5.29850	29852	29854	29857	29859	29861
26	5.29864	29866	29868	29871	29873	29875
27	5.29878	29880	29882	29884	29887	29889
28	5.29891	29893	29896	29898	29900	29902
29	5.29904	29906	29908	29911	29913	29915
30	5.29917	29919	29921	29923	29925	29927
31	5.29929	29931	29933	29935	29937	29939
32	5.29941	29943	29945	29947	29948	29950
33	5.29952	29954	29956	29958	29960	29961
34	5.29963	29965	29967	29969	29970	29972
35	5.29974	29975	29977	29979	29981	29982
36	5.29984	29986	29987	29989	29990	29992
37	5.29994	29995	29997	29998	30000	30001
38	5.30003	30004	30006	30007	30009	30010
39	5.30012	30013	30015	30016	30018	30019
40	5.30020	30022	30023	30024	30026	30027
41	5.30028	30030	30031	30032	30034	30035
42	5.30036	30037	30038	30040	30041	30042
43	5.30043	30044	30046	30047	30048	30049
44	5.30050	30051	30052	30053	30054	30055
45	5.30056	30058	30059	30060	30061	30062
46	5.30062	30063	30064	30065	30066	30067
47	5.30068	30069	30070	30071	30072	30072
48	5.30073	30074	30075	30076	30076	30077
49	5.30078	30079	30079	30080	30081	30082
50	5.30082	30083	30084	30084	30085	30086
51	5.30086	30087	30087	30088	30089	30089
52	5.30090	30090	30091	30091	30092	30092
53	5.30093	30093	30094	30094	30095	30095
54	5.30096	30096	30096	30097	30097	30097
55	5.30098	30098	30098	30099	30099	30099
56	5.30100	30100	30100	30100	30101	30101
57	5.30101	30101	30102	30102	30102	30102
58	5.30102	30102	30102	30103	30103	30103
59	5.30103	30103	30103	30103	30103	30103

TABLE XXIV.

OF NATURAL SINES.

	0°		1°		2°		3°		4°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos	N.sine.	N. cos.	
0	00000	100000	01745	99985	03490	99939	05234	99863	06976	99756	60
1	00029	100000	01774	99984	03519	99938	05263	99861	07005	99754	59
2	00058	100000	01803	99984	03548	99937	05292	99860	07034	99752	58
3	00087	100000	01832	99983	03577	99936	05321	99858	07063	99750	57
4	00116	100000	01862	99983	03606	99935	05350	99857	07092	99748	56
5	00145	100000	01891	99982	03635	99934	05379	99855	07121	99746	55
6	00175	100000	01920	99982	03664	99933	05408	99854	07150	99744	54
7	00204	100000	01949	99981	03693	99932	05437	99852	07179	99742	53
8	00233	100000	01978	99980	03723	99931	05466	99851	07208	99740	52
9	00262	100000	02007	99980	03752	99930	05495	99849	07237	99738	51
10	00291	100000	02036	99979	03781	99929	05524	99847	07266	99736	50
11	00320	99999	02065	99979	03810	99927	05553	99846	07295	99734	49
12	00349	99999	02094	99978	03839	99926	05582	99844	07324	99731	48
13	00378	99999	02123	99977	03868	99925	05611	99842	07353	99729	47
14	00407	99999	02152	99977	03897	99924	05640	99841	07382	99727	46
15	00436	99999	02181	99976	03926	99923	05669	99839	07411	99725	45
16	00465	99999	02211	99976	03955	99922	05698	99838	07440	99723	44
17	00495	99999	02240	99975	03984	99921	05727	99836	07469	99721	43
18	00524	99999	02269	99974	04013	99919	05756	99834	07498	99719	42
19	00553	99998	02298	99974	04042	99918	05785	99833	07527	99716	41
20	00582	99998	02327	99973	04071	99917	05814	99831	07556	99714	40
21	00611	99998	02356	99972	04100	99916	05844	99829	07585	99712	39
22	00640	99998	02385	99972	04129	99915	05873	99827	07614	99710	38
23	00669	99998	02414	99971	04159	99913	05902	99826	07643	99708	37
24	00698	99998	02443	99970	04188	99912	05931	99824	07672	99705	36
25	00727	99997	02472	99969	04217	99911	05960	99822	07701	99703	35
26	00756	99997	02501	99969	04246	99910	05989	99821	07730	99701	34
27	00785	99997	02530	99968	04275	99909	06018	99819	07759	99699	33
28	00814	99997	02560	99967	04304	99907	06047	99817	07788	99696	32
29	00844	99996	02589	99966	04333	99906	06076	99815	07817	99694	31
30	00873	99996	02618	99966	04362	99905	06105	99813	07846	99692	30
31	00902	99996	02647	99965	04391	99904	06134	99812	07875	99689	29
32	00931	99996	02676	99964	04420	99902	06163	99810	07904	99687	28
33	00960	99995	02705	99963	04449	99901	06192	99808	07933	99685	27
34	00989	99995	02734	99963	04478	99900	06221	99806	07962	99683	26
35	01018	99995	02763	99962	04507	99898	06250	99804	07991	99680	25
36	01047	99995	02792	99961	04536	99897	06279	99803	08020	99678	24
37	01076	99994	02821	99960	04565	99896	06308	99801	08049	99676	23
38	01105	99994	02850	99959	04594	99894	06337	99799	08078	99673	22
39	01134	99994	02879	99959	04623	99893	06366	99797	08107	99671	21
40	01164	99993	02908	99958	04653	99892	06395	99795	08136	99668	20
41	01193	99993	02938	99957	04682	99890	06424	99793	08165	99666	19
42	01222	99993	02967	99956	04711	99889	06453	99792	08194	99664	18
43	01251	99992	02996	99955	04740	99888	06482	99790	08223	99661	17
44	01280	99992	03025	99954	04769	99886	06511	99788	08252	99659	16
45	01309	99991	03054	99953	04798	99885	06540	99786	08281	99657	15
46	01338	99991	03083	99952	04827	99883	06569	99784	08310	99654	14
47	01367	99991	03112	99952	04856	99882	06598	99782	08339	99652	13
48	01396	99990	03141	99951	04885	99881	06627	99780	08368	99649	12
49	01425	99990	03170	99950	04914	99879	06656	99778	08397	99647	11
50	01454	99989	03199	99949	04943	99878	06685	99776	08426	99644	10
51	01483	99989	03228	99948	04972	99876	06714	99774	08455	99642	9
52	01513	99989	03257	99947	05001	99875	06743	99772	08484	99639	8
53	01542	99988	03286	99946	05030	99873	06773	99770	08513	99637	7
54	01571	99988	03316	99945	05059	99872	06802	99768	08542	99635	6
55	01600	99987	03345	99944	05088	99870	06831	99766	08571	99632	5
56	01629	99987	03374	99943	05117	99869	06860	99764	08600	99630	4
57	01658	99986	03403	99942	05146	99867	06889	99762	08629	99627	3
58	01687	99986	03432	99941	05175	99866	06918	99760	08658	99625	2
59	01716	99985	03461	99940	05205	99864	06947	99758	08687	99622	1
60	01745	99985	03490	99939	05234	99863	06976	99756	08716	99619	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	89°		88°		87°		86°		85°		

TABLE XXIV.

OF NATURAL SINES.

	5°		6°		7°		8°		9°		
M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	
0	08716	99619	10453	99452	12187	99255	13917	99027	15643	98769	60
1	08745	99617	10482	99449	12216	99251	13946	99023	15672	98764	59
2	08774	99614	10511	99446	12245	99248	13975	99019	15701	98760	58
3	08803	99612	10540	99443	12274	99244	14004	99015	15730	98755	57
4	08831	99609	10569	99440	12302	99240	14033	99011	15758	98751	56
5	08860	99607	10597	99437	12331	99237	14061	99006	15787	98746	55
6	08889	99604	10626	99434	12360	99233	14090	99002	15816	98741	54
7	08918	99602	10655	99431	12389	99230	14119	98998	15845	98737	53
8	08947	99599	10684	99428	12418	99226	14148	98994	15873	98732	52
9	08976	99596	10713	99424	12447	99222	14177	98990	15902	98728	51
10	09005	99594	10742	99421	12476	99219	14205	98986	15931	98723	50
11	09034	99591	10771	99418	12504	99215	14234	98982	15959	98718	49
12	09063	99588	10800	99415	12533	99211	14263	98978	15988	98714	48
13	09092	99586	10829	99412	12562	99208	14292	98973	16017	98709	47
14	09121	99583	10858	99409	12591	99204	14320	98969	16046	98704	46
15	09150	99580	10887	99406	12620	99200	14349	98965	16074	98700	45
16	09179	99578	10916	99402	12649	99197	14378	98961	16103	98695	44
17	09208	99575	10945	99399	12678	99193	14407	98957	16132	98690	43
18	09237	99572	10973	99396	12706	99189	14436	98953	16160	98686	42
19	09266	99570	11002	99393	12735	99186	14464	98948	16189	98681	41
20	09295	99567	11031	99390	12764	99182	14493	98944	16218	98676	40
21	09324	99564	11060	99386	12793	99178	14522	98940	16246	98671	39
22	09353	99562	11089	99383	12822	99175	14551	98936	16275	98667	38
23	09382	99559	11118	99380	12851	99171	14580	98931	16304	98662	37
24	09411	99556	11147	99377	12880	99167	14608	98927	16333	98657	36
25	09440	99553	11176	99374	12908	99163	14637	98923	16361	98652	35
26	09469	99551	11205	99370	12937	99160	14666	98919	16390	98648	34
27	09498	99548	11234	99367	12966	99156	14695	98914	16419	98643	33
28	09527	99545	11263	99364	12995	99152	14723	98910	16447	98638	32
29	09556	99542	11291	99360	13024	99148	14752	98906	16476	98633	31
30	09585	99540	11320	99357	13053	99144	14781	98902	16505	98629	30
31	09614	99537	11349	99354	13081	99141	14810	98897	16533	98624	29
32	09642	99534	11378	99351	13110	99137	14838	98893	16562	98619	28
33	09671	99531	11407	99347	13139	99133	14867	98889	16591	98614	27
34	09700	99528	11436	99344	13168	99129	14896	98884	16620	98609	26
35	09729	99526	11465	99341	13197	99125	14925	98880	16648	98604	25
36	09758	99523	11494	99337	13226	99122	14954	98876	16677	98600	24
37	09787	99520	11523	99334	13254	99118	14982	98871	16706	98595	23
38	09816	99517	11552	99331	13283	99114	15011	98867	16734	98590	22
39	09845	99514	11580	99327	13312	99110	15040	98863	16763	98585	21
40	09874	99511	11609	99324	13341	99106	15069	98858	16792	98580	20
41	09903	99508	11638	99320	13370	99102	15097	98854	16820	98575	19
42	09932	99506	11667	99317	13399	99098	15126	98849	16849	98570	18
43	09961	99503	11696	99314	13427	99094	15155	98845	16878	98565	17
44	09990	99500	11725	99310	13456	99091	15184	98841	16906	98561	16
45	10019	99497	11754	99307	13485	99087	15212	98836	16935	98556	15
46	10048	99494	11783	99303	13514	99083	15241	98832	16964	98551	14
47	10077	99491	11812	99300	13543	99079	15270	98827	16992	98546	13
48	10106	99488	11840	99297	13572	99075	15299	98823	17021	98541	12
49	10135	99485	11869	99293	13600	99071	15327	98818	17050	98536	11
50	10164	99482	11898	99290	13629	99067	15356	98814	17078	98531	10
51	10192	99479	11927	99286	13658	99063	15385	98809	17107	98526	9
52	10221	99476	11956	99283	13687	99059	15414	98805	17136	98521	8
53	10250	99473	11985	99279	13716	99055	15442	98800	17164	98516	7
54	10279	99470	12014	99276	13744	99051	15471	98796	17193	98511	6
55	10308	99467	12043	99272	13773	99047	15500	98791	17222	98506	5
56	10337	99464	12071	99269	13802	99043	15529	98787	17250	98501	4
57	10366	99461	12100	99265	13831	99039	15557	98782	17279	98496	3
58	10395	99458	12129	99262	13860	99035	15586	98778	17308	98491	2
59	10424	99455	12158	99258	13889	99031	15615	98773	17336	98486	1
60	10453	99452	12187	99255	13917	99027	15643	98769	17365	98481	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.
	84°		83°		82°		81°		80°		

OF NATURAL SINES.

	10°		11°		12°		13°		14°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	17365	98481	19081	98163	20791	97815	22495	97437	24192	97030	60
1	17393	98476	19109	98157	20820	97809	22523	97430	24220	97023	59
2	17422	98471	19138	98152	20848	97803	22552	97424	24249	97015	58
3	17451	98466	19167	98146	20877	97797	22580	97417	24277	97008	57
4	17479	98461	19195	98140	20905	97791	22608	97411	24305	97001	56
5	17508	98455	19224	98135	20933	97784	22637	97404	24333	96994	55
6	17537	98450	19252	98129	20962	97778	22665	97398	24362	96987	54
7	17565	98445	19281	98124	20990	97772	22693	97391	24390	96980	53
8	17594	98440	19309	98118	21019	97766	22722	97384	24418	96973	52
9	17623	98435	19338	98112	21047	97760	22750	97378	24446	96966	51
10	17651	98430	19366	98107	21076	97754	22778	97371	24474	96959	50
11	17680	98425	19395	98101	21104	97748	22807	97365	24503	96952	49
12	17708	98420	19423	98096	21132	97742	22835	97358	24531	96945	48
13	17737	98414	19452	98090	21161	97735	22863	97351	24559	96937	47
14	17766	98409	19481	98084	21189	97729	22892	97345	24587	96930	46
15	17794	98404	19509	98079	21218	97723	22920	97338	24615	96923	45
16	17823	98399	19538	98073	21246	97717	22948	97331	24644	96916	44
17	17852	98394	19566	98067	21275	97711	22977	97325	24672	96909	43
18	17880	98389	19595	98061	21303	97705	23005	97318	24700	96902	42
19	17909	98383	19623	98056	21331	97698	23033	97311	24728	96894	41
20	17937	98378	19652	98050	21360	97692	23062	97304	24756	96887	40
21	17966	98373	19680	98044	21388	97686	23090	97298	24784	96880	39
22	17995	98368	19709	98039	21417	97680	23118	97291	24813	96873	38
23	18023	98362	19737	98033	21445	97673	23146	97284	24841	96866	37
24	18052	98357	19766	98027	21474	97667	23175	97278	24869	96858	36
25	18081	98352	19794	98021	21502	97661	23203	97271	24897	96851	35
26	18109	98347	19823	98016	21530	97655	23231	97264	24925	96844	34
27	18138	98341	19851	98010	21559	97648	23260	97257	24954	96837	33
28	18166	98336	19880	98004	21587	97642	23288	97251	24982	96829	32
29	18195	98331	19908	97998	21616	97636	23316	97244	25010	96822	31
30	18224	98325	19937	97992	21644	97630	23345	97237	25038	96815	30
31	18252	98320	19965	97987	21672	97623	23373	97230	25066	96807	29
32	18281	98315	19994	97981	21701	97617	23401	97223	25094	96800	28
33	18309	98310	20022	97975	21729	97611	23429	97217	25122	96793	27
34	18338	98304	20051	97969	21758	97604	23458	97210	25151	96786	26
35	18367	98299	20079	97963	21786	97598	23486	97203	25179	96778	25
36	18395	98294	20108	97958	21814	97592	23514	97196	25207	96771	24
37	18424	98288	20136	97952	21843	97585	23542	97189	25235	96764	23
38	18452	98283	20165	97946	21871	97579	23571	97182	25263	96756	22
39	12481	98277	20193	97940	21899	97573	23599	97176	25291	96749	21
40	18509	98272	20222	97934	21928	97566	23627	97169	25320	96742	20
41	18538	98267	20250	97928	21956	97560	23656	97162	25348	96734	19
42	18567	98261	20279	97922	21985	97553	23684	97155	25376	96727	18
43	18595	98256	20307	97916	22013	97547	23712	97148	25404	96719	17
44	18624	98250	20336	97910	22041	97541	23740	97141	25432	96712	16
45	18652	98245	20364	97905	22070	97534	23769	97134	25460	96705	15
46	18681	98240	20393	97899	22098	97528	23797	97127	25488	96697	14
47	18710	98234	20421	97893	22126	97521	23825	97120	25516	96690	13
48	18738	98229	20450	97887	22155	97515	23853	97113	25545	96682	12
49	18767	98223	20478	97881	22183	97508	23882	97106	25573	96675	11
50	18795	98218	20507	97875	22212	97502	23910	97100	25601	96667	10
51	18824	98212	20535	97869	22240	97496	23938	97093	25629	96660	9
52	18852	98207	20563	97863	22268	97489	23966	97086	25657	96653	8
53	18881	98201	20592	97857	22297	97483	23995	97079	25685	96645	7
54	18910	98196	20620	97851	22325	97476	24023	97072	25713	96638	6
55	18938	98190	20649	97845	22353	97470	24051	97065	25741	96630	5
56	18967	98185	20677	97839	22382	97463	24079	97058	25769	96623	4
57	18995	98179	20706	97833	22410	97457	24108	97051	25798	96615	3
58	19024	98174	20734	97827	22438	97450	24136	97044	25826	96608	2
59	19052	98168	20763	97821	22467	97444	24164	97037	25854	96600	1
60	19081	98163	20791	97815	22495	97437	24192	97030	25882	96593	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	79°		78°		77°		76°		75°		

TABLE XXIV.

OF NATURAL SINES.

	15°		16°		17°		18°		19°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	25882	96593	27564	96126	29237	95630	30902	95106	32557	94552	60
1	25910	96585	27592	96118	29265	95622	30929	95097	32584	94542	59
2	25938	96578	27620	96110	29293	95613	30957	95088	32612	94533	58
3	25966	96570	27648	96102	29321	95605	30985	95079	32639	94523	57
4	25994	96562	27676	96094	29348	95596	31012	95070	32667	94514	56
5	26022	96555	27704	96086	29376	95588	31040	95061	32694	94504	55
6	26050	96547	27731	96078	29404	95579	31068	95052	32722	94495	54
7	26079	96540	27759	96070	29432	95571	31095	95043	32749	94485	53
8	26107	96532	27787	96062	29460	95562	31123	95033	32777	94476	52
9	26135	96524	27815	96054	29487	95554	31151	95024	32804	94466	51
10	26163	96517	27843	96046	29515	95545	31178	95015	32832	94457	50
11	26191	96509	27871	96037	29543	95536	31206	95006	32859	94447	49
12	26219	96502	27899	96029	29571	95528	31233	94997	32887	94438	48
13	26247	96494	27927	96021	29599	95519	31261	94988	32914	94428	47
14	26275	96486	27955	96013	29626	95511	31289	94979	32942	94418	46
15	26303	96479	27983	96005	29654	95502	31316	94970	32969	94409	45
16	26331	96471	28011	95997	29682	95493	31344	94961	32997	94399	44
17	26359	96463	28039	95989	29710	95485	31372	94952	33024	94390	43
18	26387	96456	28067	95981	29737	95476	31399	94943	33051	94380	42
19	26415	96448	28095	95972	29765	95467	31427	94933	33079	94370	41
20	26443	96440	28123	95964	29793	95459	31454	94924	33106	94361	40
21	26471	96433	28150	95956	29821	95450	31482	94915	33134	94351	39
22	26500	96425	28178	95948	29849	95441	31510	94906	33161	94342	38
23	26528	96417	28206	95940	29876	95433	31537	94897	33189	94332	37
24	26556	96410	28234	95931	29904	95424	31565	94888	33216	94322	36
25	26584	96402	28262	95923	29932	95415	31593	94878	33244	94313	35
26	26612	96394	28290	95915	29960	95407	31620	94869	33271	94303	34
27	26640	96386	28318	95907	29987	95398	31648	94860	33298	94293	33
28	26668	96379	28346	95898	30015	95389	31675	94851	33326	94284	32
29	26696	96371	28374	95890	30043	95380	31703	94842	33353	94274	31
30	26724	96363	28402	95882	30071	95372	31730	94832	33381	94264	30
31	26752	96355	28429	95874	30098	95363	31758	94823	33408	94254	29
32	26780	96347	28457	95865	30126	95354	31786	94814	33436	94245	28
33	26808	96340	28485	95857	30154	95345	31813	94805	33463	94235	27
34	26836	96332	28513	95849	30182	95337	31841	94795	33490	94225	26
35	26864	96324	28541	95841	30209	95328	31868	94786	33518	94215	25
36	26892	96316	28569	95832	30237	95319	31896	94777	33545	94206	24
37	26920	96308	28597	95824	30265	95310	31923	94768	33573	94196	23
38	26948	96301	28625	95816	30292	95301	31951	94758	33600	94186	22
39	26976	96293	28652	95807	30320	95293	31979	94749	33627	94176	21
40	27004	96285	28680	95799	30348	95284	32006	94740	33655	94167	20
41	27032	96277	28708	95791	30376	95275	32034	94730	33682	94157	19
42	27060	96269	28736	95782	30403	95266	32061	94721	33710	94147	18
43	27088	96261	28764	95774	30431	95257	32089	94712	33737	94137	17
44	27116	96253	28792	95766	30459	95248	32116	94702	33764	94127	16
45	27144	96246	28820	95757	30486	95240	32144	94693	33792	94118	15
46	27172	96238	28847	95749	30514	95231	32171	94684	33819	94108	14
47	27200	96230	28875	95740	30542	95222	32199	94674	33846	94098	13
48	27228	96222	28903	95732	30570	95213	32227	94665	33874	94088	12
49	27256	96214	28931	95724	30597	95204	32254	94656	33901	94078	11
50	27284	96206	28959	95715	30625	95195	32282	94646	33929	94068	10
51	27312	96198	28987	95707	30653	95186	32309	94637	33956	94058	9
52	27340	96190	29015	95698	30680	95177	32337	94627	33983	94049	8
53	27368	96182	29042	95690	30708	95168	32364	94618	34011	94039	7
54	27396	96174	29070	95681	30736	95159	32392	94609	34038	94029	6
55	27424	96166	29098	95673	30763	95150	32419	94599	34065	94019	5
56	27452	96158	29126	95664	30791	95142	32447	94590	34093	94009	4
57	27480	96150	29154	95656	30819	95133	32474	94580	34120	93999	3
58	27508	96142	29182	95647	30846	95124	32502	94571	34147	93989	2
59	27536	96134	29209	95639	30874	95115	32529	94561	34175	93979	1
60	27564	96126	29237	95630	30902	95106	32557	94552	34202	93969	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	74°		73°		72°		71°		70°		

TABLE XXIV.

OF NATURAL SINES.

	20°		21°		22°		23°		24°		
M.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	
0	34202	93969	35837	93358	37461	92718	39073	92050	40674	91355	60
1	34229	93959	35864	93348	37488	92707	39100	92039	40700	91343	59
2	34257	93949	35891	93337	37515	92697	39127	92028	40727	91331	58
3	34284	93939	35918	93327	37542	92686	39153	92016	40753	91319	57
4	34311	93929	35945	93316	37569	92675	39180	92005	40780	91307	56
5	34339	93919	35973	93306	37595	92664	39207	91994	40806	91295	55
6	34366	93909	36000	93295	37622	92653	39234	91982	40833	91283	54
7	34393	93899	36027	93285	37649	92642	39260	91971	40860	91272	53
8	34421	93889	36054	93274	37676	92631	39287	91959	40886	91260	52
9	34448	93879	36081	93264	37703	92620	39314	91948	40913	91248	51
10	34475	93869	36108	93253	37730	92609	39341	91936	40939	91236	50
11	34503	93859	36135	93243	37757	92598	39367	91925	40966	91224	49
12	34530	93849	36162	93232	37784	92587	39394	91914	40992	91212	48
13	34557	93839	36190	93222	37811	92576	39421	91902	41019	91200	47
14	34584	93829	36217	93211	37838	92565	39448	91891	41045	91188	46
15	34612	93819	36244	93201	37865	92554	39474	91879	41072	91176	45
16	34639	93809	36271	93190	37892	92543	39501	91868	41098	91164	44
17	34666	93799	36298	93180	37919	92532	39528	91856	41125	91152	43
18	34694	93789	36325	93169	37946	92521	39555	91845	41151	91140	42
19	34721	93779	36352	93159	37973	92510	39581	91833	41178	91128	41
20	34748	93769	36379	93148	37999	92499	39608	91822	41204	91116	40
21	34775	93759	36406	93137	38026	92488	39635	91810	41231	91104	39
22	34803	93748	36434	93127	38053	92477	39661	91799	41257	91092	38
23	34830	93738	36461	93116	38080	92466	39688	91787	41284	91080	37
24	34857	93728	36488	93106	38107	92455	39715	91775	41310	91068	36
25	34884	93718	36515	93095	38134	92444	39741	91764	41337	91056	35
26	34912	93708	36542	93084	38161	92432	39768	91752	41363	91044	34
27	34939	93698	36569	93074	38188	92421	39795	91741	41390	91032	33
28	34966	93688	36596	93063	38215	92410	39822	91729	41416	91020	32
29	34993	93677	36623	93052	38241	92399	39848	91718	41443	91008	31
30	35021	93667	36650	93042	38268	92388	39875	91706	41469	90996	30
31	35048	93657	36677	93031	38295	92377	39902	91694	41496	90984	29
32	35075	93647	36704	93020	38322	92366	39928	91683	41522	90972	28
33	35102	93637	36731	93010	38349	92355	39955	91671	41549	90960	27
34	35130	93626	36758	92999	38376	92343	39982	91660	41575	90948	26
35	35157	93616	36785	92988	38403	92332	40008	91648	41602	90936	25
36	35184	93606	36812	92978	38430	92321	40035	91636	41628	90924	24
37	35211	93596	36839	92967	38456	92310	40062	91625	41655	90911	23
38	35239	93585	36867	92956	38483	92299	40088	91613	41681	90899	22
39	35266	93575	36894	92945	38510	92287	40115	91601	41707	90887	21
40	35293	93565	36921	92935	38537	92276	40141	91590	41734	90875	20
41	35320	93555	36948	92924	38564	92265	40168	91578	41760	90863	19
42	35347	93544	36975	92913	38591	92254	40195	91566	41787	90851	18
43	35375	93534	37002	92902	38617	92243	40221	91555	41813	90839	17
44	35402	93524	37029	92892	38644	92231	40248	91543	41840	90826	16
45	35429	93514	37056	92881	38671	92220	40275	91531	41866	90814	15
46	35456	93503	37083	92870	38698	92209	40301	91519	41892	90802	14
47	35484	93493	37110	92859	38725	92198	40328	91508	41919	90790	13
48	35511	93483	37137	92849	38752	92186	40355	91496	41945	90778	12
49	35538	93472	37164	92838	38778	92175	40381	91484	41972	90766	11
50	35565	93462	37191	92827	38805	92164	40408	91472	41998	90753	10
51	35592	93452	37218	92816	38832	92152	40434	91461	42024	90741	9
52	35619	93441	37245	92805	38859	92141	40461	91449	42051	90729	8
53	35647	93431	37272	92794	38886	92130	40488	91437	42077	90717	7
54	35674	93420	37299	92784	38912	92119	40514	91425	42104	90704	6
55	35701	93410	37326	92773	38939	92107	40541	91414	42130	90692	5
56	35728	93400	37353	92762	38966	92096	40567	91402	42156	90680	4
57	35755	93389	37380	92751	38993	92085	40594	91390	42183	90668	3
58	35782	93379	37407	92740	39020	92073	40621	91378	42209	90655	2
59	35810	93368	37434	92729	39046	92062	40647	91366	42235	90643	1
60	35837	93358	37461	92718	39073	92050	40674	91355	42262	90631	0
	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	N. cos.	N. sine.	M.
	69°		68°		67°		66°		65°		

TABLE XXIV.

OF NATURAL SINES.

	25°		26°		27°		28°		29°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	42262	90631	43837	89879	45399	89101	46947	88295	48481	87462	60
1	42288	90618	43863	89867	45425	89087	46973	88281	48506	87448	59
2	42315	90606	43889	89854	45451	89074	46999	88267	48532	87434	58
3	42341	90594	43916	89841	45477	89061	47024	88254	48557	87420	57
4	42367	90582	43942	89828	45503	89048	47050	88240	48583	87406	56
5	42394	90569	43968	89816	45529	89035	47076	88226	48608	87391	55
6	42420	90557	43994	89803	45554	89021	47101	88213	48634	87377	54
7	42446	90545	44020	89790	45580	89008	47127	88199	48659	87363	53
8	42473	90532	44046	89777	45606	88995	47153	88185	48684	87349	52
9	42499	90520	44072	89764	45632	88981	47178	88172	48710	87335	51
10	42525	90507	44098	89752	45658	88968	47204	88158	48735	87321	50
11	42552	90495	44124	89739	45684	88955	47229	88144	48761	87306	49
12	42578	90483	44151	89726	45710	88942	47255	88130	48786	87292	48
13	42604	90470	44177	89713	45736	88928	47281	88117	48811	87278	47
14	42631	90458	44203	89700	45762	88915	47306	88103	48837	87264	46
15	42657	90446	44229	89687	45787	88902	47332	88089	48862	87250	45
16	42683	90433	44255	89674	45813	88888	47358	88075	48888	87235	44
17	42709	90421	44281	89662	45839	88875	47383	88062	48913	87221	43
18	42736	90408	44307	89649	45865	88862	47409	88048	48938	87207	42
19	42762	90396	44333	89636	45891	88848	47434	88034	48964	87193	41
20	42788	90383	44359	89623	45917	88835	47460	88020	48989	87178	40
21	42815	90371	44385	89610	45942	88822	47486	88006	49014	87164	39
22	42841	90358	44411	89597	45968	88808	47511	87993	49040	87150	38
23	42867	90346	44437	89584	45994	88795	47537	87979	49065	87136	37
24	42894	90334	44464	89571	46020	88782	47562	87965	49090	87121	36
25	42920	90321	44490	89558	46046	88768	47588	87951	49116	87107	35
26	42946	90309	44516	89545	46072	88755	47614	87937	49141	87093	34
27	42972	90296	44542	89532	46097	88741	47639	87923	49166	87079	33
28	42999	90284	44568	89519	46123	88728	47665	87909	49192	87064	32
29	43025	90271	44594	89506	46149	88715	47690	87896	49217	87050	31
30	43051	90259	44620	89493	46175	88701	47716	87882	49242	87036	30
31	43077	90246	44646	89480	46201	88688	47741	87868	49268	87021	29
32	43104	90233	44672	89467	46226	88674	47767	87854	49293	87007	28
33	43130	90221	44698	89454	46252	88661	47793	87840	49318	86993	27
34	43156	90208	44724	89441	46278	88647	47818	87826	49344	86978	26
35	43182	90196	44750	89428	46304	88634	47844	87812	49369	86964	25
36	43209	90183	44776	89415	46330	88620	47869	87798	49394	86949	24
37	43235	90171	44802	89402	46355	88607	47895	87784	49419	86935	23
38	43261	90158	44828	89389	46381	88593	47920	87770	49445	86921	22
39	43287	90146	44854	89376	46407	88580	47946	87756	49470	86906	21
40	43313	90133	44880	89363	46433	88566	47971	87743	49495	86892	20
41	43340	90120	44906	89350	46458	88553	47997	87729	49521	86878	19
42	43366	90108	44932	89337	46484	88539	48022	87715	49546	86863	18
43	43392	90095	44958	89324	46510	88526	48048	87701	49571	86849	17
44	43418	90082	44984	89311	46536	88512	48073	87687	49596	86834	16
45	43445	90070	45010	89298	46561	88499	48099	87673	49622	86820	15
46	43471	90057	45036	89285	46587	88485	48124	87659	49647	86805	14
47	43497	90045	45062	89272	46613	88472	48150	87645	49672	86791	13
48	43523	90032	45088	89259	46639	88458	48175	87631	49697	86777	12
49	43549	90019	45114	89245	46664	88445	48201	87617	49723	86762	11
50	43575	90007	45140	89232	46690	88431	48226	87603	49748	86748	10
51	43602	89994	45166	89219	46716	88417	48252	87589	49773	86733	9
52	43628	89981	45192	89206	46742	88404	48277	87575	49798	86719	8
53	43654	89968	45218	89193	46767	88390	48303	87561	49824	86704	7
54	43680	89956	45243	89180	46793	88377	48328	87546	49849	86690	6
55	43706	89943	45269	89167	46819	88363	48354	87532	49874	86675	5
56	43733	89930	45295	89153	46844	88349	48379	87518	49899	86661	4
57	43759	89918	45321	89140	46870	88336	48405	87504	49924	86646	3
58	43785	89905	45347	89127	46896	88322	48430	87490	49950	86632	2
59	43811	89892	45373	89114	46921	88308	48456	87476	49975	86617	1
60	43837	89879	45399	89101	46947	88295	48481	87462	50000	86603	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	64°		63°		62°		61°		60°		

TABLE XXIV.

OF NATURAL SINES.

	30°		31°		32°		33°		34°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	50000	86603	51504	85717	52992	84805	54464	83867	55919	82904	60
1	50025	86588	51529	85702	53017	84789	54488	83851	55943	82887	59
2	50050	86573	51554	85687	53041	84774	54513	83835	55968	82871	58
3	50076	86559	51579	85672	53066	84759	54537	83819	55992	82855	57
4	50101	86544	51604	85657	53091	84743	54561	83804	56016	82839	56
5	50126	86530	51628	85642	53115	84728	54586	83788	56040	82822	55
6	50151	86515	51653	85627	53140	84712	54610	83772	56064	82806	54
7	50176	86501	51678	85612	53164	84697	54635	83756	56088	82790	53
8	50201	86486	51703	85597	53189	84681	54659	83740	56112	82773	52
9	50227	86471	51728	85582	53214	84666	54683	83724	56136	82757	51
10	50252	86457	51753	85567	53238	84650	54708	83708	56160	82741	50
11	50277	86442	51778	85551	53263	84635	54732	83692	56184	82724	49
12	50302	86427	51803	85536	53288	84619	54756	83676	56208	82708	48
13	50327	86413	51828	85521	53312	84604	54781	83660	56232	82692	47
14	50352	86398	51852	85506	53337	84588	54805	83645	56256	82675	46
15	50377	86384	51877	85491	53361	84573	54829	83629	56280	82659	45
16	50403	86369	51902	85476	53386	84557	54854	83613	56305	82643	44
17	50428	86354	51927	85461	53411	84542	54878	83597	56329	82626	43
18	50453	86340	51952	85446	53435	84526	54902	83581	56353	82610	42
19	50478	86325	51977	85431	53460	84511	54927	83565	56377	82593	41
20	50503	86310	52002	85416	53484	84495	54951	83549	56401	82577	40
21	50528	86295	52026	85401	53509	84480	54975	83533	56425	82561	39
22	50553	86281	52051	85385	53534	84464	54999	83517	56449	82544	38
23	50578	86266	52076	85370	53558	84448	55024	83501	56473	82528	37
24	50603	86251	52101	85355	53583	84433	55048	83485	56497	82511	36
25	50628	86237	52126	85340	53607	84417	55072	83469	56521	82495	35
26	50654	86222	52151	85325	53632	84402	55097	83453	56545	82478	34
27	50679	86207	52175	85310	53656	84386	55121	83437	56569	82462	33
28	50704	86192	52200	85294	53681	84370	55145	83421	56593	82446	32
29	50729	86178	52225	85279	53705	84355	55169	83405	56617	82429	31
30	50754	86163	52250	85264	53730	84339	55194	83389	56641	82413	30
31	50779	86148	52275	85249	53754	84324	55218	83373	56665	82396	29
32	50804	86133	52299	85234	53779	84308	55242	83356	56689	82380	28
33	50829	86119	52324	85218	53804	84292	55266	83340	56713	82363	27
34	50854	86104	52349	85203	53828	84277	55291	83324	56736	82347	26
35	50879	86089	52374	85188	53853	84261	55315	83308	56760	82330	25
36	50904	86074	52399	85173	53877	84245	55339	83292	56784	82314	24
37	50929	86059	52423	85157	53902	84230	55363	83276	56808	82297	23
38	50954	86045	52448	85142	53926	84214	55388	83260	56832	82281	22
39	50979	86030	52473	85127	53951	84198	55412	83244	56856	82264	21
40	51004	86015	52498	85112	53975	84182	55436	83228	56880	82248	20
41	51029	86000	52522	85096	54000	84167	55460	83212	56904	82231	19
42	51054	85985	52547	85081	54024	84151	55484	83195	56928	82214	18
43	51079	85970	52572	85066	54049	84135	55509	83179	56952	82198	17
44	51104	85956	52597	85051	54073	84120	55533	83163	56976	82181	16
45	51129	85941	52621	85035	54097	84104	55557	83147	57000	82165	15
46	51154	85926	52646	85020	54122	84088	55581	83131	57024	82148	14
47	51179	85911	52671	85005	54146	84072	55605	83115	57047	82132	13
48	51204	85896	52696	84989	54171	84057	55630	83098	57071	82115	12
49	51229	85881	52720	84974	54195	84041	55654	83082	57095	82098	11
50	51254	85866	52745	84959	54220	84025	55678	83066	57119	82082	10
51	51279	85851	52770	84943	54244	84009	55702	83050	57143	82065	9
52	51304	85836	52794	84928	54269	83994	55726	83034	57167	82048	8
53	51329	85821	52819	84913	54293	83978	55750	83017	57191	82032	7
54	51354	85806	52844	84897	54317	83962	55775	83001	57215	82015	6
55	51379	85792	52869	84882	54342	83946	55799	82985	57238	81999	5
56	51404	85777	52893	84866	54366	83930	55823	82969	57262	81982	4
57	51429	85762	52918	84851	54391	83915	55847	82953	57286	81965	3
58	51454	85747	52943	84836	54415	83899	55871	82936	57310	81949	2
59	51479	85732	52967	84820	54440	83883	55895	82920	57334	81932	1
60	51504	85717	52992	84805	54464	83867	55919	82904	57358	81915	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	59°		58°		57°		56°		55°		

TABLE XXIV.

OF NATURAL SINES.

	35°		36°		37°		38°		39°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	57358	81915	58779	80902	60182	79864	61566	78801	62932	77715	60
1	57381	81899	58802	80885	60205	79846	61589	78783	62955	77696	59
2	57405	81882	58826	80867	60228	79829	61612	78765	62977	77678	58
3	57429	81865	58849	80850	60251	79811	61635	78747	63000	77660	57
4	57453	81848	58873	80833	60274	79793	61658	78729	63022	77641	56
5	57477	81832	58896	80816	60298	79776	61681	78711	63045	77623	55
6	57501	81815	58920	80799	60321	79758	61704	78694	63068	77605	54
7	57524	81798	58943	80782	60344	79741	61726	78676	63090	77586	53
8	57548	81782	58967	80765	60367	79723	61749	78658	63113	77568	52
9	57572	81765	58990	80748	60390	79706	61772	78640	63135	77550	51
10	57596	81748	59014	80730	60414	79688	61795	78622	63158	77531	50
11	57619	81731	59037	80713	60437	79671	61818	78604	63180	77513	49
12	57643	81714	59061	80696	60460	79653	61841	78586	63203	77494	48
13	57667	81698	59084	80679	60483	79635	61864	78568	63225	77476	47
14	57691	81681	59108	80662	60506	79618	61887	78550	63248	77458	46
15	57715	81664	59131	80644	60529	79600	61909	78532	63271	77439	45
16	57738	81647	59154	80627	60553	79583	61932	78514	63293	77421	44
17	57762	81631	59178	80610	60576	79565	61955	78496	63316	77402	43
18	57786	81614	59201	80593	60599	79547	61978	78478	63338	77384	42
19	57810	81597	59225	80576	60622	79530	62001	78460	63361	77366	41
20	57833	81580	59248	80558	60645	79512	62024	78442	63383	77347	40
21	57857	81563	59272	80541	60668	79494	62046	78424	63406	77329	39
22	57881	81546	59295	80524	60691	79477	62069	78405	63428	77310	38
23	57904	81530	59318	80507	60714	79459	62092	78387	63451	77292	37
24	57928	81513	59342	80489	60738	79441	62115	78369	63473	77273	36
25	57952	81496	59365	80472	60761	79424	62138	78351	63496	77255	35
26	57976	81479	59389	80455	60784	79406	62160	78333	63518	77236	34
27	57999	81462	59412	80438	60807	79388	62183	78315	63540	77218	33
28	58023	81445	59436	80420	60830	79371	62206	78297	63563	77199	32
29	58047	81428	59459	80403	60853	79353	62229	78279	63585	77181	31
30	58070	81412	59482	80386	60876	79335	62251	78261	63608	77162	30
31	58094	81395	59506	80368	60899	79318	62274	78243	63630	77144	29
32	58118	81378	59529	80351	60922	79300	62297	78225	63653	77125	28
33	58141	81361	59552	80334	60945	79282	62320	78206	63675	77107	27
34	58165	81344	59576	80316	60968	79264	62342	78188	63698	77088	26
35	58189	81327	59599	80299	60991	79247	62365	78170	63720	77070	25
36	58212	81310	59622	80282	61015	79229	62388	78152	63742	77051	24
37	58236	81293	59646	80264	61038	79211	62411	78134	63765	77033	23
38	58260	81276	59669	80247	61061	79193	62433	78116	63787	77014	22
39	58283	81259	59693	80230	61084	79176	62456	78098	63810	76996	21
40	58307	81242	59716	80212	61107	79158	62479	78079	63832	76977	20
41	58330	81225	59739	80195	61130	79140	62502	78061	63854	76959	19
42	58354	81208	59763	80178	61153	79122	62524	78043	63877	76940	18
43	58378	81191	59786	80160	61176	79105	62547	78025	63899	76921	17
44	58401	81174	59809	80143	61199	79087	62570	78007	63922	76903	16
45	58425	81157	59832	80125	61222	79069	62592	77988	63944	76884	15
46	58449	81140	59856	80108	61245	79051	62615	77970	63966	76866	14
47	58472	81123	59879	80091	61268	79033	62638	77952	63989	76847	13
48	58496	81106	59902	80073	61291	79016	62660	77934	64011	76828	12
49	58519	81089	59926	80056	61314	78998	62683	77916	64033	76810	11
50	58543	81072	59949	80038	61337	78980	62706	77897	64056	76791	10
51	58567	81055	59972	80021	61360	78962	62728	77879	64078	76772	9
52	58590	81038	59995	80003	61383	78944	62751	77861	64100	76754	8
53	58614	81021	60019	79986	61406	78926	62774	77843	64123	76735	7
54	58637	81004	60042	79968	61429	78908	62796	77824	64145	76717	6
55	58661	80987	60065	79951	61451	78891	62819	77806	64167	76698	5
56	58684	80970	60089	79934	61474	78873	62842	77788	64190	76679	4
57	58708	80953	60112	79916	61497	78855	62864	77769	64212	76661	3
58	58731	80936	60135	79899	61520	78837	62887	77751	64234	76642	2
59	58755	80919	60158	79881	61543	78819	62909	77733	64256	76623	1
60	58779	80902	60182	79864	61566	78801	62932	77715	64279	76604	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	54°		53°		52°		51°		50°		

TABLE XXIV.

OF NATURAL SINES.

	40°		41°		42°		43°		44°		
M.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	
0	64279	76604	65606	75471	66913	74314	68200	73135	69466	71934	60
1	64301	76586	65628	75452	66935	74295	68221	73116	69487	71914	59
2	64323	76567	65650	75433	66956	74276	68242	73096	69508	71894	58
3	64346	76548	65672	75414	66978	74256	68264	73076	69529	71873	57
4	64368	76530	65694	75395	66999	74237	68285	73056	69549	71853	56
5	64390	76511	65716	75375	67021	74217	68306	73036	69570	71833	55
6	64412	76492	65738	75356	67043	74198	68327	73016	69591	71813	54
7	64435	76473	65759	75337	67064	74178	68349	72996	69612	71792	53
8	64457	76455	65781	75318	67086	74159	68370	72976	69633	71772	52
9	64479	76436	65803	75299	67107	74139	68391	72957	69654	71752	51
10	64501	76417	65825	75280	67129	74120	68412	72937	69675	71732	50
11	64524	76398	65847	75261	67151	74100	68434	72917	69696	71711	49
12	64546	76380	65869	75241	67172	74080	68455	72897	69717	71691	48
13	64568	76361	65891	75222	67194	74061	68476	72877	69737	71671	47
14	64590	76342	65913	75203	67215	74041	68497	72857	69758	71650	46
15	64612	76323	65935	75184	67237	74022	68518	72837	69779	71630	45
16	64635	76304	65956	75165	67258	74002	68539	72817	69800	71610	44
17	64657	76286	65978	75146	67280	73983	68561	72797	69821	71590	43
18	64679	76267	66000	75126	67301	73963	68582	72777	69842	71569	42
19	64701	76248	66022	75107	67323	73944	68603	72757	69862	71549	41
20	64723	76229	66044	75088	67344	73924	68624	72737	69883	71529	40
21	64746	76210	66066	75069	67366	73904	68645	72717	69904	71508	39
22	64768	76192	66088	75050	67387	73885	68666	72697	69925	71488	38
23	64790	76173	66109	75030	67409	73865	68688	72677	69946	71468	37
24	64812	76154	66131	75011	67430	73846	68709	72657	69966	71447	36
25	64834	76135	66153	74992	67452	73826	68730	72637	69987	71427	35
26	64856	76116	66175	74973	67473	73806	68751	72617	70008	71407	34
27	64878	76097	66197	74953	67495	73787	68772	72597	70029	71386	33
28	64901	76078	66218	74934	67516	73767	68793	72577	70049	71366	32
29	64923	76059	66240	74915	67538	73747	68814	72557	70070	71345	31
30	64945	76041	66262	74896	67559	73728	68835	72537	70091	71325	30
31	64967	76022	66284	74876	67580	73708	68857	72517	70112	71305	29
32	64989	76003	66306	74857	67602	73688	68878	72497	70132	71284	28
33	65011	75984	66327	74838	67623	73669	68899	72477	70153	71264	27
34	65033	75965	66349	74818	67645	73649	68920	72457	70174	71243	26
35	65055	75946	66371	74799	67666	73629	68941	72437	70195	71223	25
36	65077	75927	66393	74780	67688	73610	68962	72417	70215	71203	24
37	65100	75908	66414	74760	67709	73590	68983	72397	70236	71182	23
38	65122	75889	66436	74741	67730	73570	69004	72377	70257	71162	22
39	65144	75870	66458	74722	67752	73551	69025	72357	70277	71141	21
40	65166	75851	66480	74703	67773	73531	69046	72337	70298	71121	20
41	65188	75832	66501	74683	67795	73511	69067	72317	70319	71100	19
42	65210	75813	66523	74664	67816	73491	69088	72297	70339	71080	18
43	65232	75794	66545	74644	67837	73472	69109	72277	70360	71059	17
44	65254	75775	66566	74625	67859	73452	69130	72257	70381	71039	16
45	65276	75756	66588	74606	67880	73432	69151	72236	70401	71019	15
46	65298	75738	66610	74586	67901	73413	69172	72216	70422	70998	14
47	65320	75719	66632	74567	67923	73393	69193	72196	70443	70978	13
48	65342	75700	66653	74548	67944	73373	69214	72176	70463	70957	12
49	65364	75680	66675	74528	67965	73353	69235	72156	70484	70937	11
50	65386	75661	66697	74509	67987	73333	69256	72136	70505	70916	10
51	65408	75642	66718	74489	68008	73314	69277	72116	70525	70896	9
52	65430	75623	66740	74470	68029	73294	69298	72095	70546	70875	8
53	65452	75604	66762	74451	68051	73274	69319	72075	70567	70855	7
54	65474	75585	66783	74431	68072	73254	69340	72055	70587	70834	6
55	65496	75566	66805	74412	68093	73234	69361	72035	70608	70813	5
56	65518	75547	66827	74392	68115	73215	69382	72015	70628	70793	4
57	65540	75528	66848	74373	68136	73195	69403	71995	70649	70772	3
58	65562	75509	66870	74353	68157	73175	69424	71974	70670	70752	2
59	65584	75490	66891	74334	68179	73155	69445	71954	70690	70731	1
60	65606	75471	66913	74314	68200	73135	69466	71934	70711	70711	0
	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	N. cos.	N.sine.	M.
	49°		48°		47°		46°		45°		

TABLE XXV.

Of Logarithmic Sines, Tangents, and Secants to every Point and Quarter Point of the Compass.

Points.	Sine.	Co. sine.	Tangent.	Co. tang.	Secant.	Co. secant.	
0	Inf. neg.	10.00000	Inf. neg.	Infinite.	10.00000	Infinite.	8
0 ¼	8.69080	9.99948	8.69132	11.30868	10.00052	11.30920	7 ¾
0 ½	8.99130	9.99790	8.99340	11.00660	10.00210	11.00870	7 ½
0 ¾	9.16652	9.99527	9.17125	10.82875	10.00473	10.83348	7 ¼
1	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	7
1 ¼	9.38557	9.98679	9.39879	10.60121	10.01321	10.61443	6 ¾
1 ½	9.46282	9.98088	9.48194	10.51806	10.01912	10.53718	6 ½
1 ¾	9.52749	9.97384	9.55365	10.44635	10.02616	10.47251	6 ¼
2	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	6
2 ¼	9.63099	9.95616	9.67483	10.32517	10.04384	10.36901	5 ¾
2 ½	9.67339	9.94543	9.72796	10.27204	10.05457	10.32661	5 ½
2 ¾	9.71105	9.93335	9.77770	10.22230	10.06665	10.28895	5 ¼
3	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	5
3 ¼	9.77503	9.90483	9.87020	10.12980	10.09517	10.22497	4 ¾
3 ½	9.80236	9.88819	9.91417	10.08583	10.11181	10.19764	4 ½
3 ¾	9.82708	9.86979	9.95729	10.04271	10.13021	10.17292	4 ¼
4	9.84949	9.84949	10.00000	10.00000	10.15051	10.15051	4
	Co. sine.	Sine.	Co. tang.	Tangent.	Co. secant.	Secant	Points.

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 1——100. Log. 0.00000——2.00000.

N.	Log.	N.	Log.	N.	Log.	N.	Log.	N.	Log.
1	0.00000	21	1.32222	41	1.61278	61	1.78533	81	1.90849
2	0.30103	22	1.34242	42	1.62325	62	1.79239	82	1.91381
3	0.47712	23	1.36173	43	1.63347	63	1.79934	83	1.91908
4	0.60206	24	1.38021	44	1.64345	64	1.80618	84	1.92428
5	0.69897	25	1.39794	45	1.65321	65	1.81291	85	1.92942
6	0.77815	26	1.41497	46	1.66276	66	1.81954	86	1.93450
7	0.84510	27	1.43136	47	1.67210	67	1.82607	87	1.93952
8	0.90309	28	1.44716	48	1.68124	68	1.83251	88	1.94448
9	0.95424	29	1.46240	49	1.69020	69	1.83885	89	1.94939
10	1.00000	30	1.47712	50	1.69897	70	1.84510	90	1.95424
11	1.04139	31	1.49136	51	1.70757	71	1.85126	91	1.95904
12	1.07918	32	1.50515	52	1.71600	72	1.85733	92	1.96379
13	1.11394	33	1.51851	53	1.72428	73	1.86332	93	1.96848
14	1.14613	34	1.53148	54	1.73239	74	1.86923	94	1.97313
15	1.17609	35	1.54407	55	1.74036	75	1.87506	95	1.97772
16	1.20412	36	1.55630	56	1.74819	76	1.88081	96	1.98227
17	1.23045	37	1.56820	57	1.75587	77	1.88649	97	1.98677
18	1.25527	38	1.57978	58	1.76343	78	1.89209	98	1.99123
19	1.27875	39	1.59106	59	1.77085	79	1.89763	99	1.99564
20	1.30103	40	1.60206	60	1.77815	80	1.90309	100	2.00000

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 100——1600. Log. 00000——20412.

No.	0	1	2	3	4	5	6	7	8	9
100	00000	00043	00087	00130	00173	00217	00260	00303	00346	00389
101	00432	00475	00518	00561	00604	00647	00689	00732	00775	00817
102	00860	00903	00945	00988	01030	01072	01115	01157	01199	01242
103	01284	01326	01368	01410	01452	01494	01536	01578	01620	01662
104	01703	01745	01787	01828	01870	01912	01953	01995	02036	02078
105	02119	02160	02202	02243	02284	02325	02366	02407	02449	02490
106	02531	02572	02612	02653	02694	02735	02776	02816	02857	02898
107	02938	02979	03019	03060	03100	03141	03181	03222	03262	03302
108	03342	03383	03423	03463	03503	03543	03583	03623	03663	03703
109	03743	03782	03822	03862	03902	03941	03981	04021	04060	04100
110	04139	04179	04218	04258	04297	04336	04376	04415	04454	04493
111	04532	04571	04610	04650	04689	04727	04766	04805	04844	04883
112	04922	04961	04999	05038	05077	05115	05154	05192	05231	05269
113	05308	05346	05385	05423	05461	05500	05538	05576	05614	05652
114	05690	05729	05767	05805	05843	05881	05918	05956	05994	06032
115	06070	06108	06145	06183	06221	06258	06296	06333	06371	06408
116	06446	06483	06521	06558	06595	06633	06670	06707	06744	06781
117	06819	06856	06893	06930	06967	07004	07041	07078	07115	07151
118	07188	07225	07262	07298	07335	07372	07408	07445	07482	07518
119	07555	07591	07628	07664	07700	07737	07773	07809	07346	07882
120	07918	07954	07990	08027	08063	08099	08135	08171	08207	08243
121	08279	08314	08350	08386	08422	08458	08493	08529	08565	08600
122	08636	08672	08707	08743	08778	08814	08849	08884	08920	08955
123	08991	09026	09061	09096	09132	09167	09202	09237	09272	09307
124	09342	09377	09412	09447	09482	09517	09552	09587	09621	09656
125	09691	09726	09760	09795	09830	09864	09899	09934	09968	10003
126	10037	10072	10106	10140	10175	10209	10243	10273	10312	10346
127	10380	10415	10449	10483	10517	10551	10585	10619	10653	10687
128	10721	10755	10789	10823	10857	10890	10924	10958	10992	11025
129	11059	11093	11126	11160	11193	11227	11261	11294	11327	11361
130	11394	11428	11461	11494	11528	11561	11594	11628	11661	11694
131	11727	11760	11793	11826	11860	11893	11926	11959	11992	12024
132	12057	12090	12123	12156	12189	12222	12254	12287	12320	12352
133	12385	12418	12450	12483	12516	12548	12581	12613	12646	12678
134	12710	12743	12775	12808	12840	12872	12905	12937	12969	13001
135	13033	13066	13098	13130	13162	13194	13226	13258	13290	13322
136	13354	13386	13418	13450	13481	13513	13545	13577	13609	13640
137	13672	13704	13735	13767	13799	13830	13862	13893	13925	13956
138	13988	14019	14051	14082	14114	14145	14176	14208	14239	14270
139	14301	14333	14364	14395	14426	14457	14489	14520	14551	14582
140	14613	14644	14675	14706	14737	14768	14799	14829	14860	14891
141	14922	14953	14983	15014	15045	15076	15106	15137	15168	15198
142	15229	15259	15290	15320	15351	15381	15412	15442	15473	15503
143	15534	15564	15594	15625	15655	15685	15715	15746	15776	15806
144	15836	15866	15897	15927	15957	15987	16017	16047	16077	16107
145	16137	16167	16197	16227	16256	16286	16316	16346	16376	16406
146	16435	16465	16495	16524	16554	16584	16613	16643	16673	16702
147	16732	16761	16791	16820	16850	16879	16909	16938	16967	16997
148	17026	17056	17085	17114	17143	17173	17202	17231	17260	17289
149	17319	17348	17377	17406	17435	17464	17493	17522	17551	17580
150	17609	17638	17667	17696	17725	17754	17782	17811	17840	17869
151	17898	17926	17955	17984	18013	18041	18070	18099	18127	18156
152	18184	18213	18241	18270	18298	18327	18355	18384	18412	18441
153	18469	18498	18526	18554	18583	18611	18639	18667	18696	18724
154	18752	18780	18808	18837	18865	18893	18921	18949	18977	19005
155	19033	19061	19089	19117	19145	19173	19201	19229	19257	19285
156	19312	19340	19368	19396	19424	19451	19479	19507	19535	19562
157	19590	19618	19645	19673	19700	19728	19756	19783	19811	19833
158	19866	19893	19921	19948	19976	20003	20030	20058	20085	20112
159	20140	20167	20194	20222	20249	20276	20303	20330	20358	20335
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 1600——2200. Log. 20412——34242.

No.	0	1	2	3	4	5	6	7	8	9
160	20412	20439	20466	20493	20520	20548	20575	20602	20629	20656
161	20683	20710	20737	20763	20790	20817	20844	20871	20898	20925
162	20952	20978	21005	21032	21059	21085	21112	21139	21165	21192
163	21219	21245	21272	21299	21325	21352	21378	21405	21431	21458
164	21484	21511	21537	21564	21590	21617	21643	21669	21696	21722
165	21748	21775	21801	21827	21854	21880	21906	21932	21958	21985
166	22011	22037	22063	22089	22115	22141	22167	22194	22220	22246
167	22272	22298	22324	22350	22376	22401	22427	22453	22479	22505
168	22531	22557	22583	22608	22634	22660	22686	22712	22737	22763
169	22789	22814	22840	22866	22891	22917	22943	22968	22994	23019
170	23045	23070	23096	23121	23147	23172	23198	23223	23249	23274
171	23300	23325	23350	23376	23401	23426	23452	23477	23502	23528
172	23553	23578	23603	23629	23654	23679	23704	23729	23754	23779
173	23805	23830	23855	23880	23905	23930	23955	23980	24005	24030
174	24055	24080	24105	24130	24155	24180	24204	24229	24254	24279
175	24304	24329	24353	24378	24403	24428	24452	24477	24502	24527
176	24551	24576	24601	24625	24650	24674	24699	24724	24748	24773
177	24797	24822	24846	24871	24895	24920	24944	24969	24993	25018
178	25042	25066	25091	25115	25139	25164	25188	25212	25237	25261
179	25285	25310	25334	25358	25382	25406	25431	25455	25479	25503
180	25527	25551	25575	25600	25624	25648	25672	25696	25720	25744
181	25768	25792	25816	25840	25864	25888	25912	25935	25959	25983
182	26007	26031	26055	26079	26102	26126	26150	26174	26198	26221
183	26245	26269	26293	26316	26340	26364	26387	26411	26435	26458
184	26482	26505	26529	26553	26576	26600	26623	26647	26670	26694
185	26717	26741	26764	26788	26811	26834	26858	26881	26905	26928
186	26951	26975	26998	27021	27045	27068	27091	27114	27138	27161
187	27184	27207	27231	27254	27277	27300	27323	27346	27370	27393
188	27416	27439	27462	27485	27508	27531	27554	27577	27600	27623
189	27646	27669	27692	27715	27738	27761	27784	27807	27830	27852
190	27875	27898	27921	27944	27967	27989	28012	28035	28058	28081
191	28103	28126	28149	28171	28194	28217	28240	28262	28285	28307
192	28330	28353	28375	28398	28421	28443	28466	28488	28511	28533
193	28556	28578	28601	28623	28646	28668	28691	28713	28735	28758
194	28780	28803	28825	28847	28870	28892	28914	28937	28959	28981
195	29003	29026	29048	29070	29092	29115	29137	29159	29181	29203
196	29226	29248	29270	29292	29314	29336	29358	29380	29403	29425
197	29447	29469	29491	29513	29535	29557	29579	29601	29623	29645
198	29667	29688	29710	29732	29754	29776	29798	29820	29842	29863
199	29885	29907	29929	29951	29973	29994	30016	30038	30060	30081
200	30103	30125	30146	30168	30190	30211	30233	30255	30276	30298
201	30320	30341	30363	30384	30406	30428	30449	30471	30492	30514
202	30535	30557	30578	30600	30621	30643	30664	30685	30707	30728
203	30750	30771	30792	30814	30835	30856	30878	30899	30920	30942
204	30963	30984	31006	31027	31048	31069	31091	31112	31133	31154
205	31175	31197	31218	31239	31260	31281	31302	31323	31345	31366
206	31387	31408	31429	31450	31471	31492	31513	31534	31555	31576
207	31597	31618	31639	31660	31681	31702	31723	31744	31765	31785
208	31806	31827	31848	31869	31890	31911	31931	31952	31973	31994
209	32015	32035	32056	32077	32098	32118	32139	32160	32181	32201
210	32222	32243	32263	32284	32305	32325	32346	32366	32387	32408
211	32428	32449	32469	32490	32510	32531	32552	32572	32593	32613
212	32634	32654	32675	32695	32715	32736	32756	32777	32797	32818
213	32838	32858	32879	32899	32919	32940	32960	32980	33001	33021
214	33041	33062	33082	33102	33122	33143	33163	33183	33203	33224
215	33244	33264	33284	33304	33325	33345	33365	33385	33405	33425
216	33445	33465	33486	33506	33526	33546	33566	33586	33606	33626
217	33646	33666	33686	33706	33726	33746	33766	33786	33806	33826
218	33846	33866	33885	33905	33925	33945	33965	33985	34005	34025
219	34044	34064	34084	34104	34124	34143	34163	34183	34203	34223
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 2200——2800. Log. 34242——44716.

No.	0	1	2	3	4	5	6	7	8	9
220	34242	34262	34282	34301	34321	34341	34361	34380	34400	34420
221	34439	34459	34479	34498	34518	34537	34557	34577	34596	34616
222	34635	34655	34674	34694	34713	34733	34753	34772	34792	34811
223	34830	34850	34869	34889	34908	34928	34947	34967	34986	35005
224	35025	35044	35064	35083	35102	35122	35141	35160	35180	35199
225	35218	35238	35257	35276	35295	35315	35334	35353	35372	35392
226	35411	35430	35449	35468	35488	35507	35526	35545	35564	35583
227	35603	35622	35641	35660	35679	35698	35717	35736	35755	35774
228	35793	35813	35832	35851	35870	35889	35908	35927	35946	35965
229	35984	36003	36021	36040	36059	36078	36097	36116	36135	36154
230	36173	36192	36211	36229	36248	36267	36286	36305	36324	36342
231	36361	36380	36399	36418	36436	36455	36474	36493	36511	36530
232	36549	36568	36586	36605	36624	36642	36661	36680	36698	36717
233	36736	36754	36773	36791	36810	36829	36847	36866	36884	36903
234	36922	36940	36959	36977	36996	37014	37033	37051	37070	37088
235	37107	37125	37144	37162	37181	37199	37218	37236	37254	37273
236	37291	37310	37328	37346	37365	37383	37401	37420	37438	37457
237	37475	37493	37511	37530	37548	37566	37585	37603	37621	37639
238	37658	37676	37694	37712	37731	37749	37767	37785	37803	37822
239	37840	37858	37876	37894	37912	37931	37949	37967	37985	38003
240	38021	38039	38057	38075	38093	38112	38130	38148	38166	38184
241	38202	38220	38238	38256	38274	38292	38310	38328	38346	38364
242	38382	38399	38417	38435	38453	38471	38489	38507	38525	38543
243	38561	38578	38596	38614	38632	38650	38668	38686	38703	38721
244	38739	38757	38775	38792	38810	38828	38846	38863	38881	38899
245	38917	38934	38952	38970	38987	39005	39023	39041	39058	39076
246	39094	39111	39129	39146	39164	39182	39199	39217	39235	39252
247	39270	39287	39305	39322	39340	39358	39375	39393	39410	39428
248	39445	39463	39480	39498	39515	39533	39550	39568	39585	39602
249	39620	39637	39655	39672	39690	39707	39724	39742	39759	39777
250	39794	39811	39829	39846	39863	39881	39898	39915	39933	39950
251	39967	39985	40002	40019	40037	40054	40071	40088	40106	40123
252	40140	40157	40175	40192	40209	40226	40243	40261	40278	40295
253	40312	40329	40346	40364	40381	40398	40415	40432	40449	40466
254	40483	40500	40518	40535	40552	40569	40586	40603	40620	40637
255	40654	40671	40688	40705	40722	40739	40756	40773	40790	40807
256	40824	40841	40858	40875	40892	40909	40926	40943	40960	40976
257	40993	41010	41027	41044	41061	41078	41095	41111	41128	41145
258	41162	41179	41196	41212	41229	41246	41263	41280	41296	41313
259	41330	41347	41363	41380	41397	41414	41430	41447	41464	41481
260	41497	41514	41531	41547	41564	41581	41597	41614	41631	41647
261	41664	41681	41697	41714	41731	41747	41764	41780	41797	41814
262	41830	41847	41863	41880	41896	41913	41929	41946	41963	41979
263	41996	42012	42029	42045	42062	42078	42095	42111	42127	42144
264	42160	42177	42193	42210	42226	42243	42259	42275	42292	42308
265	42325	42341	42357	42374	42390	42406	42423	42439	42455	42472
266	42488	42504	42521	42537	42553	42570	42586	42602	42619	42635
267	42651	42667	42684	42700	42716	42732	42749	42765	42781	42797
268	42813	42830	42846	42862	42878	42894	42911	42927	42943	42959
269	42975	42991	43008	43024	43040	43056	43072	43088	43104	43120
270	43136	43152	43169	43185	43201	43217	43233	43249	43265	43281
271	43297	43313	43329	43345	43361	43377	43393	43409	43425	43441
272	43457	43473	43489	43505	43521	43537	43553	43569	43584	43600
273	43616	43632	43648	43664	43680	43696	43712	43727	43743	43759
274	43775	43791	43807	43823	43838	43854	43870	43886	43902	43917
275	43933	43949	43965	43981	43996	44012	44028	44044	44059	44075
276	44091	44107	44122	44138	44154	44170	44185	44201	44217	44232
277	44248	44264	44279	44295	44311	44326	44342	44358	44373	44389
278	44404	44420	44436	44451	44467	44483	44498	44514	44529	44545
279	44560	44576	44592	44607	44623	44638	44654	44669	44685	44700
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 2800——3400. Log. 44716——53148.

No.	0	1	2	3	4	5	6	7	8	9
280	44716	44731	44747	44762	44778	44793	44809	44824	44840	44855
281	44871	44886	44902	44917	44932	44948	44963	44979	44994	45010
282	45025	45040	45056	45071	45086	45102	45117	45133	45148	45163
283	45179	45194	45209	45225	45240	45255	45271	45286	45301	45317
284	45332	45347	45362	45378	45393	45408	45423	45439	45454	45469
285	45484	45500	45515	45530	45545	45561	45576	45591	45606	45621
286	45637	45652	45667	45682	45697	45712	45728	45743	45758	45773
287	45788	45803	45818	45834	45849	45864	45879	45894	45909	45924
288	45939	45954	45969	45984	46000	46015	46030	46045	46060	46075
289	46090	46105	46120	46135	46150	46165	46180	46195	46210	46225
290	46240	46255	46270	46285	46300	46315	46330	46345	46359	46374
291	46389	46404	46419	46434	46449	46464	46479	46494	46509	46523
292	46538	46553	46568	46583	46598	46613	46627	46642	46657	46672
293	46687	46702	46716	46731	46746	46761	46776	46790	46805	46820
294	46835	46850	46864	46879	46894	46909	46923	46938	46953	46967
295	46982	46997	47012	47026	47041	47056	47070	47085	47100	47114
296	47129	47144	47159	47173	47188	47202	47217	47232	47246	47261
297	47276	47290	47305	47319	47334	47349	47363	47378	47392	47407
298	47422	47436	47451	47465	47480	47494	47509	47524	47538	47553
299	47567	47582	47596	47611	47625	47640	47654	47669	47683	47698
300	47712	47727	47741	47756	47770	47784	47799	47813	47828	47842
301	47857	47871	47885	47900	47914	47929	47943	47958	47972	47986
302	48001	48015	48029	48044	48058	48073	48087	48101	48116	48130
303	48144	48159	48173	48187	48202	48216	48230	48244	48259	48273
304	48287	48302	48316	48330	48344	48359	48373	48387	48401	48416
305	48430	48444	48458	48473	48487	48501	48515	48530	48544	48558
306	48572	48586	48601	48615	48629	48643	48657	48671	48686	48700
307	48714	48728	48742	48756	48770	48785	48799	48813	48827	48841
308	48855	48869	48883	48897	48911	48926	48940	48954	48968	48982
309	48996	49010	49024	49038	49052	49066	49080	49094	49108	49122
310	49136	49150	49164	49178	49192	49206	49220	49234	49248	49262
311	49276	49290	49304	49318	49332	49346	49360	49374	49388	49402
312	49415	49429	49443	49457	49471	49485	49499	49513	49527	49541
313	49554	49568	49582	49596	49610	49624	49638	49651	49665	49679
314	49693	49707	49721	49734	49748	49762	49776	49790	49803	49817
315	49831	49845	49859	49872	49886	49900	49914	49927	49941	49955
316	49969	49982	49996	50010	50024	50037	50051	50065	50079	50092
317	50106	50120	50133	50147	50161	50174	50188	50202	50215	50229
318	50243	50256	50270	50284	50297	50311	50325	50338	50352	50365
319	50379	50393	50406	50420	50433	50447	50461	50474	50488	50501
320	50515	50529	50542	50556	50569	50583	50596	50610	50623	50637
321	50651	50664	50678	50691	50705	50718	50732	50745	50759	50772
322	50786	50799	50813	50826	50840	50853	50866	50880	50893	50907
323	50920	50934	50947	50961	50974	50987	51001	51014	51028	51041
324	51055	51068	51081	51095	51108	51121	51135	51148	51162	51175
325	51188	51202	51215	51228	51242	51255	51268	51282	51295	51308
326	51322	51335	51348	51362	51375	51388	51402	51415	51428	51441
327	51455	51468	51481	51495	51508	51521	51534	51548	51561	51574
328	51587	51601	51614	51627	51640	51654	51667	51680	51693	51706
329	51720	51733	51746	51759	51772	51786	51799	51812	51825	51838
330	51851	51865	51878	51891	51904	51917	51930	51943	51957	51970
331	51983	51996	52009	52022	52035	52048	52061	52075	52088	52101
332	52114	52127	52140	52153	52166	52179	52192	52205	52218	52231
333	52244	52257	52270	52284	52297	52310	52323	52336	52349	52362
334	52375	52388	52401	52414	52427	52440	52453	52466	52479	52492
335	52504	52517	52530	52543	52556	52569	52582	52595	52608	52621
336	52634	52647	52660	52673	52686	52699	52711	52724	52737	52750
337	52763	52776	52789	52802	52815	52827	52840	52853	52866	52879
338	52892	52905	52917	52930	52943	52956	52969	52982	52994	53007
339	53020	53033	53046	53058	53071	53084	53097	53110	53122	53135
No.	0	1	2	3	4	5	6	7	8	9

LOGARITHMS OF NUMBERS.

No. 3400———4000. Log. 53148———60206.

No.	0	1	2	3	4	5	6	7	8	9
340	53148	53161	53173	53186	53199	53212	53224	53237	53250	53263
341	53275	53288	53301	53314	53326	53339	53352	53364	53377	53390
342	53403	53415	53428	53441	53453	53466	53479	53491	53504	53517
343	53529	53542	53555	53567	53580	53593	53605	53618	53631	53643
344	53656	53668	53681	53694	53706	53719	53732	53744	53757	53769
345	53782	53794	53807	53820	53832	53845	53857	53870	53882	53895
346	53908	53920	53933	53945	53958	53970	53983	53995	54008	54020
347	54033	54045	54058	54070	54083	54095	54108	54120	54133	54145
348	54158	54170	54183	54195	54208	54220	54233	54245	54258	54270
349	54283	54295	54307	54320	54332	54345	54357	54370	54382	54394
350	54407	54419	54432	54444	54456	54469	54481	54494	54506	54518
351	54531	54543	54555	54568	54580	54593	54605	54617	54630	54642
352	54654	54667	54679	54691	54704	54716	54728	54741	54753	54765
353	54777	54790	54802	54814	54827	54839	54851	54864	54876	54888
354	54900	54913	54925	54937	54949	54962	54974	54986	54998	55011
355	55023	55035	55047	55060	55072	55084	55096	55108	55121	55133
356	55145	55157	55169	55182	55194	55206	55218	55230	55242	55255
357	55267	55279	55291	55303	55315	55328	55340	55352	55364	55376
358	55388	55400	55413	55425	55437	55449	55461	55473	55485	55497
359	55509	55522	55534	55546	55558	55570	55582	55594	55606	55618
360	55630	55642	55654	55666	55678	55691	55703	55715	55727	55739
361	55751	55763	55775	55787	55799	55811	55823	55835	55847	55859
362	55871	55883	55895	55907	55919	55931	55943	55955	55967	55979
363	55991	56003	56015	56027	56038	56050	56062	56074	56086	56098
364	56110	56122	56134	56146	56158	56170	56182	56194	56205	56217
365	56229	56241	56253	56265	56277	56289	56301	56312	56324	56336
366	56348	56360	56372	56384	56396	56407	56419	56431	56443	56455
367	56467	56478	56490	56502	56514	56526	56538	56549	56561	56573
368	56585	56597	56608	56620	56632	56644	56656	56667	56679	56691
369	56703	56714	56726	56738	56750	56761	56773	56785	56797	56808
370	56820	56832	56844	56855	56867	56879	56891	56902	56914	56926
371	56937	56949	56961	56972	56984	56996	57008	57019	57031	57043
372	57054	57066	57078	57089	57101	57113	57124	57136	57148	57159
373	57171	57183	57194	57206	57217	57229	57241	57252	57264	57276
374	57287	57299	57310	57322	57334	57345	57357	57368	57380	57392
375	57403	57415	57426	57438	57449	57461	57473	57484	57496	57507
376	57519	57530	57542	57553	57565	57576	57588	57600	57611	57623
377	57634	57646	57657	57669	57680	57692	57703	57715	57726	57738
378	57749	57761	57772	57784	57795	57807	57818	57830	57841	57852
379	57864	57875	57887	57898	57910	57921	57933	57944	57955	57967
380	57978	57990	58001	58013	58024	58035	58047	58058	58070	58081
381	58092	58104	58115	58127	58138	58149	58161	58172	58184	58195
382	58206	58218	58229	58240	58252	58263	58274	58286	58297	58309
383	58320	58331	58343	58354	58365	58377	58388	58399	58410	58422
384	58433	58444	58456	58467	58478	58490	58501	58512	58524	58535
385	58546	58557	58569	58580	58591	58602	58614	58625	58636	58647
386	58659	58670	58681	58692	58704	58715	58726	58737	58749	58760
387	58771	58782	58794	58805	58816	58827	58838	58850	58861	58872
388	58883	58894	58906	58917	58928	58939	58950	58961	58973	58984
389	58995	59006	59017	59028	59040	59051	59062	59073	59084	59095
390	59106	59118	59129	59140	59151	59162	59173	59184	59195	59207
391	59218	59229	59240	59251	59262	59273	59284	59295	59306	59318
392	59329	59340	59351	59362	59373	59384	59395	59406	59417	59428
393	59439	59450	59461	59472	59483	59494	59506	59517	59528	59539
394	59550	59561	59572	59583	59594	59605	59616	59627	59638	59649
395	59660	59671	59682	59693	59704	59715	59726	59737	59748	59759
396	59770	59780	59791	59802	59813	59824	59835	59846	59857	59868
397	59879	59890	59901	59912	59923	59934	59945	59956	59966	59977
398	59988	59999	60010	60021	60032	60043	60054	60065	60076	60086
399	60097	60108	60119	60130	60141	60152	60163	60173	60184	60195
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 4000——4600. Log. 60206——66276.

No.	0	1	2	3	4	5	6	7	8	9
400	60206	60217	60228	60239	60249	60260	60271	60282	60293	60304
401	60314	60325	60336	60347	60358	60369	60379	60390	60401	60412
402	60423	60433	60444	60455	60466	60477	60487	60498	60509	60520
403	60531	60541	60552	60563	60574	60584	60595	60606	60617	60627
404	60638	60649	60660	60670	60681	60692	60703	60713	60724	60735
405	60746	60756	60767	60778	60788	60799	60810	60821	60831	60842
406	60853	60863	60874	60885	60895	60906	60917	60927	60938	60949
407	60959	60970	60981	60991	61002	61013	61023	61034	61045	61055
408	61066	61077	61087	61098	61109	61119	61130	61140	61151	61162
409	61172	61183	61194	61204	61215	61225	61236	61247	61257	61268
410	61278	61289	61300	61310	61321	61331	61342	61352	61363	61374
411	61384	61395	61405	61416	61426	61437	61448	61458	61469	61479
412	61490	61500	61511	61521	61532	61542	61553	61563	61574	61584
413	61595	61606	61616	61627	61637	61648	61658	61669	61679	61690
414	61700	61711	61721	61731	61742	61752	61763	61773	61784	61794
415	61805	61815	61826	61836	61847	61857	61868	61878	61888	61899
416	61909	61920	61930	61941	61951	61962	61972	61982	61993	62003
417	62014	62024	62034	62045	62055	62066	62076	62086	62097	62107
418	62118	62128	62138	62149	62159	62170	62180	62190	62201	62211
419	62221	62232	62242	62252	62263	62273	62284	62294	62304	62315
420	62325	62335	62346	62356	62366	62377	62387	62397	62408	62418
421	62428	62439	62449	62459	62469	62480	62490	62500	62511	62521
422	62531	62542	62552	62562	62572	62583	62593	62603	62613	62624
423	62634	62644	62655	62665	62675	62685	62696	62706	62716	62726
424	62737	62747	62757	62767	62778	62788	62798	62808	62818	62829
425	62839	62849	62859	62870	62880	62890	62900	62910	62921	62931
426	62941	62951	62961	62972	62982	62992	63002	63012	63022	63033
427	63043	63053	63063	63073	63083	63094	63104	63114	63124	63134
428	63144	63155	63165	63175	63185	63195	63205	63215	63225	63236
429	63246	63256	63266	63276	63286	63296	63306	63317	63327	63337
430	63347	63357	63367	63377	63387	63397	63407	63417	63428	63438
431	63448	63458	63468	63478	63488	63498	63508	63518	63528	63538
432	63548	63558	63568	63579	63589	63599	63609	63619	63629	63639
433	63649	63659	63669	63679	63689	63699	63709	63719	63729	63739
434	63749	63759	63769	63779	63789	63799	63809	63819	63829	63839
435	63849	63859	63869	63879	63889	63899	63909	63919	63929	63939
436	63949	63959	63969	63979	63988	63998	64008	64018	64028	64038
437	64048	64058	64068	64078	64088	64098	64108	64118	64128	64137
438	64147	64157	64167	64177	64187	64197	64207	64217	64227	64237
439	64246	64256	64266	64276	64286	64296	64306	64316	64326	64335
440	64345	64355	64365	64375	64385	64395	64404	64414	64424	64434
441	64444	64454	64464	64473	64483	64493	64503	64513	64523	64532
442	64542	64552	64562	64572	64582	64591	64601	64611	64621	64631
443	64640	64650	64660	64670	64680	64689	64699	64709	64719	64729
444	64738	64748	64758	64768	64777	64787	64797	64807	64816	64826
445	64836	64846	64856	64865	64875	64885	64895	64904	64914	64924
446	64933	64943	64953	64963	64972	64982	64992	65002	65011	65021
447	65031	65040	65050	65060	65070	65079	65089	65099	65108	65118
448	65128	65137	65147	65157	65167	65176	65186	65196	65205	65215
449	65225	65234	65244	65254	65263	65273	65283	65292	65302	65312
450	65321	65331	65341	65350	65360	65369	65379	65389	65398	65408
451	65418	65427	65437	65447	65456	65466	65475	65485	65495	65504
452	65514	65523	65533	65543	65552	65562	65571	65581	65591	65600
453	65610	65619	65629	65639	65648	65658	65667	65677	65686	65696
454	65706	65715	65725	65734	65744	65753	65763	65772	65782	65792
455	65801	65811	65820	65830	65839	65849	65858	65868	65877	65887
456	65896	65906	65916	65925	65935	65944	65954	65963	65973	65982
457	65992	66001	66011	66020	6603[illegible]	66039	66049	66058	66068	66077
458	66087	66096	66106	66115	66124	6613[illegible]	66143	66153	66162	66172
459	66181	66191	66200	66210	66219	66229	66238	66247	66257	66266
No.	0	1	2	3	4	5	6	7	8	9

LOGARITHMS OF NUMBERS.

No. 4600———5200. Log. 66276———71600.

No.	0	1	2	3	4	5	6	7	8	9
460	66276	66285	66295	66304	66314	66323	66332	66342	66351	66361
461	66370	66380	66389	66398	66408	66417	66427	66436	66445	66455
462	66464	66474	66483	66492	66502	66511	66521	66530	66539	66549
463	66558	66567	66577	66586	66596	66605	66614	66624	66633	66642
464	66652	66661	66671	66680	66689	66699	66708	66717	66727	66736
465	66745	66755	66764	66773	66783	66792	66801	66811	66820	66829
466	66839	66848	66857	66867	66876	66885	66894	66904	66913	66922
467	66932	66941	66950	66960	66969	66978	66987	66997	67006	67015
468	67025	67034	67043	67052	67062	67071	67080	67089	67099	67108
469	67117	67127	67136	67145	67154	67164	67173	67182	67191	67201
470	67210	67219	67228	67237	67247	67256	67265	67274	67284	67293
471	67302	67311	67321	67330	67339	67348	67357	67367	67376	67385
472	67394	67403	67413	67422	67431	67440	67449	67459	67468	67477
473	67486	67495	67504	67514	67523	67532	67541	67550	67560	67569
474	67578	67587	67596	67605	67614	67624	67633	67642	67651	67660
475	67669	67679	67688	67697	67706	67715	67724	67733	67742	67752
476	67761	67770	67779	67788	67797	67806	67815	67825	67834	67843
477	67852	67861	67870	67879	67888	67897	67906	67916	67925	67934
478	67943	67952	67961	67970	67979	67988	67997	68006	68015	68024
479	68034	68043	68052	68061	68070	68079	68088	68097	68106	68115
480	68124	68133	68142	68151	68160	68169	68178	68187	68196	68205
481	68215	68224	68233	68242	68251	68260	68269	68278	68287	68296
482	68305	68314	68323	68332	68341	68350	68359	68368	68377	68386
483	68395	68404	68413	68422	68431	68440	68449	68458	68467	68476
484	68485	68494	68502	68511	68520	68529	68538	68547	68556	68565
485	68574	68583	68592	68601	68610	68619	68628	68637	68646	68655
486	68664	68673	68681	68690	68699	68708	68717	68726	68735	68744
487	68753	68762	68771	68780	68789	68797	68806	68815	68824	68833
488	68842	68851	68860	68869	68878	68886	68895	68904	68913	68922
489	68931	68940	68949	68958	68966	68975	68984	68993	69002	69011
490	69020	69028	69037	69046	69055	69064	69073	69082	69090	69099
491	69108	69117	69126	69135	69144	69152	69161	69170	69179	69188
492	69197	69205	69214	69223	69232	69241	69249	69258	69267	69276
493	69285	69294	69302	69311	69320	69329	69338	69346	69355	69364
494	69373	69381	69390	69399	69408	69417	69425	69434	69443	69452
495	69461	69469	69478	69487	69496	69504	69513	69522	69531	69539
496	69548	69557	69566	69574	69583	69592	69601	69609	69618	69627
497	69636	69644	69653	69662	69671	69679	69688	69697	69705	69714
498	69723	69732	69740	69749	69758	69767	69775	69784	69793	69801
499	69810	69819	69827	69836	69845	69854	69862	69871	69880	69888
500	69897	69906	69914	69923	69932	69940	69949	69958	69966	69975
501	69984	69992	70001	70010	70018	70027	70036	70044	70053	70062
502	70070	70079	70088	70096	70105	70114	70122	70131	70140	70148
503	70157	70165	70174	70183	70191	70200	70209	70217	70226	70234
504	70243	70252	70260	70269	70278	70286	70295	70303	70312	70321
505	70329	70338	70346	70355	70364	70372	70381	70389	70398	70406
506	70415	70424	70432	70441	70449	70458	70467	70475	70484	70492
507	70501	70509	70518	70526	70535	70544	70552	70561	70569	70578
508	70586	70595	70603	70612	70621	70629	70638	70646	70655	70663
509	70672	70680	70689	70697	70706	70714	70723	70731	70740	70749
510	70757	70766	70774	70783	70791	70800	70808	70817	70825	70834
511	70842	70851	70859	70868	70876	70885	70893	70902	70910	70919
512	70927	70935	70944	70952	70961	70969	70978	70986	70995	71003
513	71012	71020	71029	71037	71046	71054	71063	71071	71079	71088
514	71096	71105	71113	71122	71130	71139	71147	71155	71164	71172
515	71181	71189	71198	71206	71214	71223	71231	71240	71248	71257
516	71265	71273	71282	71290	71299	71307	71315	71324	71332	71341
517	71349	71357	71366	71374	71383	71391	71399	71408	71416	71425
518	71433	71441	71450	71458	71466	71475	71483	71492	71500	71508
519	71517	71525	71533	71542	71550	71559	71567	71575	71584	71592
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 5200——5800. Log. 71600——76343.

No.	0	1	2	3	4	5	6	7	8	9
520	71600	71609	71617	71625	71634	71642	71650	71659	71667	71675
521	71684	71692	71700	71709	71717	71725	71734	71742	71750	71759
522	71767	71775	71784	71792	71800	71809	71817	71825	71834	71842
523	71850	71858	71867	71875	71883	71892	71900	71908	71917	71925
524	71933	71941	71950	71958	71966	71975	71983	71991	71999	72008
525	72016	72024	72032	72041	72049	72057	72066	72074	72082	72090
526	72099	72107	72115	72123	72132	72140	72148	72156	72165	72173
527	72181	72189	72198	72206	72214	72222	72230	72239	72247	72255
528	72263	72272	72280	72288	72296	72304	72313	72321	72329	72337
529	72346	72354	72362	72370	72378	72387	72395	72403	72411	72419
530	72428	72436	72444	72452	72460	72469	72477	72485	72493	72501
531	72509	72518	72526	72534	72542	72550	72558	72567	72575	72583
532	72591	72599	72607	72616	72624	72632	72640	72648	72656	72665
533	72673	72681	72689	72697	72705	72713	72722	72730	72738	72746
534	72754	72762	72770	72779	72787	72795	72803	72811	72819	72827
535	72835	72843	72852	72860	72868	72876	72884	72892	72900	72908
536	72916	72925	72933	72941	72949	72957	72965	72973	72981	72989
537	72997	73006	73014	73022	73030	73038	73046	73054	73062	73070
538	73078	73086	73094	73102	73111	73119	73127	73135	73143	73151
539	73159	73167	73175	73183	73191	73199	73207	73215	73223	73231
540	73239	73247	73255	73263	73272	73280	73288	73296	73304	73312
541	73320	73328	73336	73344	73352	73360	73368	73376	73384	73392
542	73400	73408	73416	73424	73432	73440	73448	73456	73464	73472
543	73480	73488	73496	73504	73512	73520	73528	73536	73544	73552
544	73560	73568	73576	73584	73592	73600	73608	73616	73624	73632
545	73640	73648	73656	73664	73672	73679	73687	73695	73703	73711
546	73719	73727	73735	73743	73751	73759	73767	73775	73783	73791
547	73799	73807	73815	73823	73830	73838	73846	73854	73862	73870
548	73878	73886	73894	73902	73910	73918	73926	73933	73941	73949
549	73957	73965	73973	73981	73989	73997	74005	74013	74020	74028
550	74036	74044	74052	74060	74068	74076	74084	74092	74099	74107
551	74115	74123	74131	74139	74147	74155	74162	74170	74178	74186
552	74194	74202	74210	74218	74225	74233	74241	74249	74257	74265
553	74273	74280	74288	74296	74304	74312	74320	74327	74335	74343
554	74351	74359	74367	74374	74382	74390	74398	74406	74414	74421
555	74429	74437	74445	74453	74461	74468	74476	74484	74492	74500
556	74507	74515	74523	74531	74539	74547	74554	74562	74570	74578
557	74586	74593	74601	74609	74617	74624	74632	74640	74648	74656
558	74663	74671	74679	74687	74695	74702	74710	74718	74726	74733
559	74741	74749	74757	74764	74772	74780	74788	74796	74803	74811
560	74819	74827	74834	74842	74850	74858	74865	74873	74881	74889
561	74896	74904	74912	74920	74927	74935	74943	74950	74958	74966
562	74974	74981	74989	74997	75005	75012	75020	75028	75035	75043
563	75051	75059	75066	75074	75082	75089	75097	75105	75113	75120
564	75128	75136	75143	75151	75159	75166	75174	75182	75189	75197
565	75205	75213	75220	75228	75236	75243	75251	75259	75266	75274
566	75282	75289	75297	75305	75312	75320	75328	75335	75343	75351
567	75358	75366	75374	75381	75389	75397	75404	75412	75420	75427
568	75435	75442	75450	75458	75465	75473	75481	75488	75496	75504
569	75511	75519	75526	75534	75542	75549	75557	75565	75572	75580
570	75587	75595	75603	75610	75618	75626	75633	75641	75648	75656
571	75664	75671	75679	75686	75694	75702	75709	75717	75724	75732
572	75740	75747	75755	75762	75770	75778	75785	75793	75800	75808
573	75815	75823	75831	75838	75846	75853	75861	75868	75876	75884
574	75891	75899	75906	75914	75921	75929	75937	75944	75952	75959
575	75967	75974	75982	75989	75997	76005	76012	76020	76027	76035
576	76042	76050	76057	76065	76072	76080	76087	76095	76103	76110
577	76118	76125	76133	76140	76148	76155	76163	76170	76178	76185
578	76193	76200	76208	76215	76223	76230	76238	76245	76253	76260
579	76268	76275	76283	76290	76298	76305	76313	76320	76328	76335
No.	0	1	2	3	4	5	6	7	8	9

LOGARITHMS OF NUMBERS.

No. 5800——6400. Log. 76343——80618.

No.	0	1	2	3	4	5	6	7	8	9
580	76343	76350	76358	76365	76373	76380	76388	76395	76403	76410
581	76418	76425	76433	76440	76448	76455	76462	76470	76477	76485
582	76492	76500	76507	76515	76522	76530	76537	76545	76552	76559
583	76567	76574	76582	76589	76597	76604	76612	76619	76626	76634
584	76641	76649	76656	76664	76671	76678	76686	76693	76701	76708
585	76716	76723	76730	76738	76745	76753	76760	76768	76775	76782
586	76790	76797	76805	76812	76819	76827	76834	76842	76849	76856
587	76864	76871	76879	76886	76893	76901	76908	76916	76923	76930
588	76938	76945	76953	76960	76967	76975	76982	76989	76997	77004
589	77012	77019	77026	77034	77041	77048	77056	77063	77070	77078
590	77085	77093	77100	77107	77115	77122	77129	77137	77144	77151
591	77159	77166	77173	77181	77188	77195	77203	77210	77217	77225
592	77232	77240	77247	77254	77262	77269	77276	77283	77291	77298
593	77305	77313	77320	77327	77335	77342	77349	77357	77364	77371
594	77379	77386	77393	77401	77408	77415	77422	77430	77437	77444
595	77452	77459	77466	77474	77481	77488	77495	77503	77510	77517
596	77525	77532	77539	77546	77554	77561	77568	77576	77583	77590
597	77597	77605	77612	77619	77627	77634	77641	77648	77656	77663
598	77670	77677	77685	77692	77699	77706	77714	77721	77728	77735
599	77743	77750	77757	77764	77772	77779	77786	77793	77801	77808
600	77815	77822	77830	77837	77844	77851	77859	77866	77873	77880
601	77887	77895	77902	77909	77916	77924	77931	77938	77945	77952
602	77960	77967	77974	77981	77988	77996	78003	78010	78017	78025
603	78032	78039	78046	78053	78061	78068	78075	78082	78089	78097
604	78104	78111	78118	78125	78132	78140	78147	78154	78161	78168
605	78176	78183	78190	78197	78204	78211	78219	78226	78233	78240
606	78247	78254	78262	78269	78276	78283	78290	78297	78305	78312
607	78319	78326	78333	78340	78347	78355	78362	78369	78376	78383
608	78390	78398	78405	78412	78419	78426	78433	78440	78447	78455
609	78462	78469	78476	78483	78490	78497	78504	78512	78519	78526
610	78533	78540	78547	78554	78561	78569	78576	78583	78590	78597
611	78604	78611	78618	78625	78633	78640	78647	78654	78661	78668
612	78675	78682	78689	78696	78704	78711	78718	78725	78732	78739
613	78746	78753	78760	78767	78774	78781	78789	78796	78803	78810
614	78817	78824	78831	78838	78845	78852	78859	78866	78873	78880
615	78888	78895	78902	78909	78916	78923	78930	78937	78944	78951
616	78958	78965	78972	78979	78986	78993	79000	79007	79014	79021
617	79029	79036	79043	79050	79057	79064	79071	79078	79085	79092
618	79099	79106	79113	79120	79127	79134	79141	79148	79155	79162
619	79169	79176	79183	79190	79197	79204	79211	79218	79225	79232
620	79239	79246	79253	79260	79267	79274	79281	79288	79295	79302
621	79309	79316	79323	79330	79337	79344	79351	79358	79365	79372
622	79379	79386	79393	79400	79407	79414	79421	79428	79435	79442
623	79449	79456	79463	79470	79477	79484	79491	79498	79505	79511
624	79518	79525	79532	79539	79546	79553	79560	79567	79574	79581
625	79588	79595	79602	79609	79616	79623	79630	79637	79644	79650
626	79657	79664	79671	79678	79685	79692	79699	79706	79713	79720
627	79727	79734	79741	79748	79754	79761	79768	79775	79782	79789
628	79796	79803	79810	79817	79824	79831	79837	79844	79851	79858
629	79865	79872	79879	79886	79893	79900	79906	79913	79920	79927
630	79934	79941	79948	79965	79962	79969	79975	79982	79989	79996
631	80003	80010	80017	80024	80030	80037	80044	80051	80058	80065
632	80072	80079	80085	80092	80099	80106	80113	80120	80127	80134
633	80140	80147	80154	80161	80168	80175	80182	80188	80195	80202
634	80209	80216	80223	80229	80236	80243	80250	80257	80264	80271
635	80277	80284	80291	80298	80305	80312	80318	80325	80332	80339
636	80346	80353	80359	80366	80373	80380	80387	80393	80400	80407
637	80414	80421	80428	80434	80441	80448	80455	80462	80468	80475
638	80482	80489	80496	80502	80509	80516	80523	80530	80536	80543
639	80550	80557	80564	80570	80577	80584	80591	80598	80604	80611
No.	0	1	2	3	4	5	6	7	8	9

LOGARITHMS OF NUMBERS.

No. 6400——7000. Log. 80618——84510.

No.	0	1	2	3	4	5	6	7	8	9
640	80618	80625	80632	80638	80645	80652	80659	80665	80672	80679
641	80686	80693	80699	80706	80713	80720	80726	80733	80740	80747
642	80754	80760	80767	80774	80781	80787	80794	80801	80808	80814
643	80821	80828	80835	80841	80848	80855	80862	80868	80875	80882
644	80889	80895	80902	80909	80916	80922	80929	80936	80943	80949
645	80956	80963	80969	80976	80983	80990	80996	81003	81010	81017
646	81023	81030	81037	81043	81050	81057	81064	81070	81077	81084
647	81090	81097	81104	81111	81117	81124	81131	81137	81144	81151
648	81158	81164	81171	81178	81184	81191	81198	81204	81211	81218
649	81224	81231	81238	81245	81251	81258	81265	81271	81278	81285
650	81291	81298	81305	81311	81318	81325	81331	81338	81345	81351
651	81358	81365	81371	81378	81385	81391	81398	81405	81411	81418
652	81425	81431	81438	81445	81451	81458	81465	81471	81478	81485
653	81491	81498	81505	81511	81518	81525	81531	81538	81544	81551
654	81558	81564	81571	81578	81584	81591	81598	81604	81611	81617
655	81624	81631	81637	81644	81651	81657	81664	81671	81677	81684
656	81690	81697	81704	81710	81717	81723	81730	81737	81743	81750
657	81757	81763	81770	81776	81783	81790	81796	81803	81809	81816
658	81823	81829	81836	81842	81849	81856	81862	81869	81875	81882
659	81889	81895	81902	81908	81915	81921	81928	81935	81941	81948
660	81954	81961	81968	81974	81981	81987	81994	82000	82007	82014
661	82020	82027	82033	82040	82046	82053	82060	82066	82073	82079
662	82086	82092	82099	82105	82112	82119	82125	82132	82138	82145
663	82151	82158	82164	82171	82178	82184	82191	82197	82204	82210
664	82217	82223	82230	82236	82243	82249	82256	82263	82269	82276
665	82282	82289	82295	82302	82308	82315	82321	82328	82334	82341
666	82347	82354	82360	82367	82373	82380	82387	82393	82400	82406
667	82413	82419	82426	82432	82439	82445	82452	82458	82465	82471
668	82478	82484	82491	82497	82504	82510	82517	82523	82530	82536
669	82543	82549	82556	82562	82569	82575	82582	82588	82595	82601
670	82607	82614	82620	82627	82633	82640	82646	82653	82659	82666
671	82672	82679	82685	82692	82698	82705	82711	82718	82724	82730
672	82737	82743	82750	82756	82763	82769	82776	82782	82789	82795
673	82802	82808	82814	82821	82827	82834	82840	82847	82853	82860
674	82866	82872	82879	82885	82892	82898	82905	82911	82918	82924
675	82930	82937	82943	82950	82956	82963	82969	82975	82982	82988
676	82995	83001	83008	83014	83020	83027	83033	83040	83046	83052
677	83059	83065	83072	83078	83085	83091	83097	83104	83110	83117
678	83123	83129	83136	83142	83149	83155	83161	83168	83174	83181
679	83187	83193	83200	83206	83213	83219	83225	83232	83238	83245
680	83251	83257	83264	83270	83276	83283	83289	83296	83302	83308
681	83315	83321	83327	83334	83340	83347	83353	83359	83366	83372
682	83378	83385	83391	83398	83404	83410	83417	83423	83429	83436
683	83442	83448	83455	83461	83467	83474	83480	83487	83493	83499
684	83506	83512	83518	83525	83531	83537	83544	83550	83556	83563
685	83569	83575	83582	83588	83594	83601	83607	83613	83620	83626
686	83632	83639	83645	83651	83658	83664	83670	83677	83683	83689
687	83696	83702	83708	83715	83721	83727	83734	83740	83746	83753
688	83759	83765	83771	83778	83784	83790	83797	83803	83809	83816
689	83822	83828	83835	83841	83847	83853	83860	83866	83872	83879
690	83885	83891	83897	83904	83910	83916	83923	83929	83935	83942
691	83948	83954	83960	83967	83973	83979	83985	83992	83998	84004
692	84011	84017	84023	84029	84036	84042	84048	84055	84061	84067
693	84073	84080	84086	84092	84098	84105	84111	84117	84123	84130
694	84136	84142	84148	84155	84161	84167	84173	84180	84186	84192
695	84198	84205	84211	84217	84223	84230	84236	84242	84248	84255
696	84261	84267	84273	84280	84286	84292	84298	84305	84311	84317
697	84323	84330	84336	84342	84348	84354	84361	84367	84373	84379
698	84386	84392	84398	84404	84410	84417	84423	84429	84435	84442
699	84448	84454	84460	84466	84473	84479	84485	84491	84497	84504
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 7000———7600. Log. 84510———88081.

No.	0	1	2	3	4	5	6	7	8	9
700	84510	84516	84522	84528	84535	84541	84547	84553	84559	84566
701	84572	84578	84584	84590	84597	84603	84609	84615	84621	84628
702	84634	84640	84646	84652	84658	84665	84671	84677	84683	84689
703	84696	84702	84708	84714	84720	84726	84733	84739	84745	84751
704	84757	84763	84770	84776	84782	84788	84794	84800	84807	84813
705	84819	84825	84831	84837	84844	84850	84856	84862	84868	84874
706	84880	84887	84893	84899	84905	84911	84917	84924	84930	84936
707	84942	84948	84954	84960	84967	84973	84979	84985	84991	84997
708	85003	85009	85016	85022	85028	85034	85040	85046	85052	85058
709	85065	85071	85077	85083	85089	85095	85101	85107	85114	85120
710	85126	85132	85138	85144	85150	85156	85163	85169	85175	85181
711	85187	85193	85199	85205	85211	85217	85224	85230	85236	85242
712	85248	85254	85260	85266	85272	85278	85285	85291	85297	85303
713	85309	85315	85321	85327	85333	85339	85345	85352	85358	85364
714	85370	85376	85382	85388	85394	85400	85406	85412	85418	85425
715	85431	85437	85443	85449	85455	85461	85467	85473	85479	85485
716	85491	85497	85503	85509	85516	85522	85528	85534	85540	85546
717	85552	85558	85564	85570	85576	85582	85588	85594	85600	85606
718	85612	85618	85625	85631	85637	85643	85649	85655	85661	85667
719	85673	85679	85685	85691	85697	85703	85709	85715	85721	85727
720	85733	85739	85745	85751	85757	85763	85769	85775	85781	85788
721	85794	85800	85806	85812	85818	85824	85830	85836	85842	85848
722	85854	85860	85866	85872	85878	85884	85890	85896	85902	85908
723	85914	85920	85926	85932	85938	85944	85950	85956	85962	85968
724	85974	85980	85986	85992	85998	86004	86010	86016	86022	86028
725	86034	86040	86046	86052	86058	86064	86070	86076	86082	86088
726	86094	86100	86106	86112	86118	86124	86130	86136	86141	86147
727	86153	86159	86165	86171	86177	86183	86189	86195	86201	86207
728	86213	86219	86225	86231	86237	86243	86249	86255	86261	86267
729	86273	86279	86285	86291	86297	86303	86308	86314	86320	86326
730	86332	86338	86344	86350	86356	86362	86368	86374	86380	86386
731	86392	86398	86404	86410	86415	86421	86427	86433	86439	86445
732	86451	86457	86463	86469	86475	86481	86487	86493	86499	86504
733	86510	86516	86522	86528	86534	86540	86546	86552	86558	86564
734	86570	86576	86581	86587	86593	86599	86605	86611	86617	86623
735	86629	86635	86641	86646	86652	86658	86664	86670	86676	86682
736	86688	86694	86700	86705	86711	86717	86723	86729	86735	86741
737	86747	86753	86759	86764	86770	86776	86782	86788	86794	86800
738	86806	86812	86817	86823	86829	86835	86841	86847	86853	86859
739	86864	86870	86876	86882	86888	86894	86900	86906	86911	86917
740	86923	86929	86935	86941	86947	86953	86958	86964	86970	86976
741	86982	86988	86994	86999	87005	87011	87017	87023	87029	87035
742	87040	87046	87052	87058	87064	87070	87075	87081	87087	87093
743	87099	87105	87111	87116	87122	87128	87134	87140	87146	87151
744	87157	87163	87169	87175	87181	87186	87192	87198	87204	87210
745	87216	87221	87227	87233	87239	87245	87251	87256	87262	87268
746	87274	87280	87286	87291	87297	87303	87309	87315	87320	87326
747	87332	87338	87344	87349	87355	87361	87367	87373	87379	87384
748	87390	87396	87402	87408	87413	87419	87425	87431	87437	87442
749	87448	87454	87460	87466	87471	87477	87483	87489	87495	87500
750	87506	87512	87518	87523	87529	87535	87541	87547	87552	87558
751	87564	87570	87576	87581	87587	87593	87599	87604	87610	87616
752	87622	87628	87633	87639	87645	87651	87656	87662	87668	87674
753	87679	87685	87691	87697	87703	87708	87714	87720	87726	87731
754	87737	87743	87749	87754	87760	87766	87772	87777	87783	87789
755	87795	87800	87806	87812	87818	87823	87829	87835	87841	87846
756	87852	87858	87864	87869	87875	87881	87887	87892	87898	87904
757	87910	87915	87921	87927	87933	87938	87944	87950	87955	87961
758	87967	87973	87978	87984	87990	87996	88001	88007	88013	88018
759	88024	88030	88036	88041	88047	88053	88058	88064	88070	88076
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 7600——8200. Log. 88081——91381.

No.	0	1	2	3	4	5	6	7	8	9
760	88081	88087	88093	88098	88104	88110	88116	88121	88127	88133
761	88138	88144	88150	88156	88161	88167	88173	88178	88184	88190
762	88195	88201	88207	88213	88218	88224	88230	88235	88241	88247
763	88252	88258	88264	88270	88275	88281	88287	88292	88298	88304
764	88309	88315	88321	88326	88332	88338	88343	88349	88355	88360
765	88366	88372	88377	88383	88389	88395	88400	88406	88412	88417
766	88423	88429	88434	88440	88446	88451	88457	88463	88468	88474
767	88480	88485	88491	88497	88502	88508	88513	88519	88525	88530
768	88536	88542	88547	88553	88559	88564	88570	88576	88581	88587
769	88593	88598	88604	88610	88615	88621	88627	88632	88638	88643
770	88649	88655	88660	88666	88672	88677	88683	88689	88694	88700
771	88705	88711	88717	88722	88728	88734	88739	88745	88750	88756
772	88762	88767	88773	88779	88784	88790	88795	88801	88807	88812
773	88818	88824	88829	88835	88840	88846	88852	88857	88863	88868
774	88874	88880	88885	88891	88897	88902	88908	88913	88919	88925
775	88930	88936	88941	88947	88953	88958	88964	88969	88975	88981
776	88986	88992	88997	89003	89009	89014	89020	89025	89031	89037
777	89042	89048	89053	89059	89064	89070	89076	89081	89087	89092
778	89098	89104	89109	89115	89120	89126	89131	89137	89143	89148
779	89154	89159	89165	89170	89176	89182	89187	89193	89198	89204
780	89209	89215	89221	89226	89232	89237	89243	89248	89254	89260
781	89265	89271	89276	89282	89287	89293	89298	89304	89310	89315
782	89321	89326	89332	89337	89343	89348	89354	89360	89365	89371
783	89376	89382	89387	89393	89398	89404	89409	89415	89421	89426
784	89432	89437	89443	89448	89454	89459	89465	89470	89476	89481
785	89487	89492	89498	89504	89509	89515	89520	89526	89531	89537
786	89542	89548	89553	89559	89564	89570	89575	89581	89586	89592
787	89597	89603	89609	89614	89620	89625	89631	89636	89642	89647
788	89653	89658	89664	89669	89675	89680	89686	89691	89697	89702
789	89708	89713	89719	89724	89730	89735	89741	89746	89752	89757
790	89763	89768	89774	89779	89785	89790	89796	89801	89807	89812
791	89818	89823	89829	89834	89840	89845	89851	89856	89862	89867
792	89873	89878	89883	89889	89894	89900	89905	89911	89916	89922
793	89927	89933	89938	89944	89949	89955	89960	89966	89971	89977
794	89982	89988	89993	89998	90004	90009	90015	90020	90026	90031
795	90037	90042	90048	90053	90059	90064	90069	90075	90080	90086
796	90091	90097	90102	90108	90113	90119	90124	90129	90135	90140
797	90146	90151	90157	90162	90168	90173	90179	90184	90189	90195
798	90200	90206	90211	90217	90222	90227	90233	90238	90244	90249
799	90255	90260	90266	90271	90276	90282	90287	90293	90298	90304
800	90309	90314	90320	90325	90331	90336	90342	90347	90352	90358
801	90363	90369	90374	90380	90385	90390	90396	90401	90407	90412
802	90417	90423	90428	90434	90439	90445	90450	90455	90461	90466
803	90472	90477	90482	90488	90493	90499	90504	90509	90515	90520
804	90526	90531	90536	90542	90547	90553	90558	90563	90569	90574
805	90580	90585	90590	90596	90601	90607	90612	90617	90623	90628
806	90634	90639	90644	90650	90655	90660	90666	90671	90677	90682
807	90687	90693	90698	90703	90709	90714	90720	90725	90730	90736
808	90741	90747	90752	90757	90763	90768	90773	90779	90784	90789
809	90795	90800	90806	90811	90816	90822	90827	90832	90838	90843
810	90849	90854	90859	90865	90870	90875	90881	90886	90891	90897
811	90902	90907	90913	90918	90924	90929	90934	90940	90945	90950
812	90956	90961	90966	90972	90977	90982	90988	90993	90998	91004
813	91009	91014	91020	91025	91030	91036	91041	91046	91052	91057
814	91062	91068	91073	91078	91084	91089	91094	91100	91105	91110
815	91116	91121	91126	91132	91137	91142	91148	91153	91158	91164
816	91169	91174	91180	91185	91190	91196	91201	91206	91212	91217
817	91222	91228	91233	91238	91243	91249	91254	91259	91265	91270
818	91275	91281	91286	91291	91297	91302	91307	91312	91318	91323
819	91328	91334	91339	91344	91350	91355	91360	91365	91371	91376
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 8200——8800. Log. 91381——94448.

No.	0	1	2	3	4	5	6	7	8	9
820	91381	91387	91392	91397	91403	91408	91413	91418	91424	91429
821	91434	91440	91445	91450	91455	91461	91466	91471	91477	91482
822	91487	91492	91498	91503	91508	91514	91519	91524	91529	91535
823	91540	91545	91551	91556	91561	91566	91572	91577	91582	91587
824	91593	91598	91603	91609	91614	91619	91624	91630	91635	91640
825	91645	91651	91656	91661	91666	91672	91677	91682	91687	91693
826	91698	91703	91709	91714	91719	91724	91730	91735	91740	91745
827	91751	91756	91761	91766	91772	91777	91782	91787	91793	91798
828	91803	91808	91814	91819	91824	91829	91834	91840	91845	91850
829	91855	91861	91866	91871	91876	91882	91887	91892	91897	91903
830	91908	91913	91918	91924	91929	91934	91939	91944	91950	91955
831	91960	91965	91971	91976	91981	91986	91991	91997	92002	92007
832	92012	92018	92023	92028	92033	92038	92044	92049	92054	92059
833	92065	92070	92075	92080	92085	92091	92096	92101	92106	92111
834	92117	92122	92127	92132	92137	92143	92148	92153	92158	92163
835	92169	92174	92179	92184	92189	92195	92200	92205	92210	92215
836	92221	92226	92231	92236	92241	92247	92252	92257	92262	92267
837	92273	92278	92283	92288	92293	92298	92304	92309	92314	92319
838	92324	92330	92335	92340	92345	92350	92355	92361	92366	92371
839	92376	92381	92387	92392	92397	92402	92407	92412	92418	92423
840	92428	92433	92438	92443	92449	92454	92459	92464	92469	92474
841	92480	92485	92490	92495	92500	92505	92511	92516	92521	92526
842	92531	92536	92542	92547	92552	92557	92562	92567	92572	92578
843	92583	92588	92593	92598	92603	92609	92614	92619	92624	92629
844	92634	92639	92645	92650	92655	92660	92665	92670	92675	92681
845	92686	92691	92696	92701	92706	92711	92716	92722	92727	92732
846	92737	92742	92747	92752	92758	92763	92768	92773	92778	92783
847	92788	92793	92799	92804	92809	92814	92819	92824	92829	92834
848	92840	92845	92850	92855	92860	92865	92870	92875	92881	92886
849	92891	92896	92901	92906	92911	92916	92921	92927	92932	92937
850	92942	92947	92952	92957	92962	92967	92973	92978	92983	92988
851	92993	92998	93003	93008	93013	93018	93024	93029	93034	93039
852	93044	93049	93054	93059	93064	93069	93075	93080	93085	93090
853	93095	93100	93105	93110	93115	93120	93125	93131	93136	93141
854	93146	93151	93156	93161	93166	93171	93176	93181	93186	93192
855	93197	93202	93207	93212	93217	93222	93227	93232	93237	93242
856	93247	93252	93258	93263	93268	93273	93278	93283	93288	93293
857	93298	93303	93308	93313	93318	93323	93328	93334	93339	93344
858	93349	93354	93359	93364	93369	93374	93379	93384	93389	93394
859	93399	93404	93409	93414	93420	93425	93430	93435	93440	93445
860	93450	93455	93460	93465	93470	93475	93480	93485	93490	93495
861	93500	93505	93510	93515	93520	93526	93531	93536	93541	93546
862	93551	93556	93561	93566	93571	93576	93581	93586	93591	93596
863	93601	93606	93611	93616	93621	93626	93631	93636	93641	93646
864	93651	93656	93661	93666	93671	93676	93682	93687	93692	93697
865	93702	93707	93712	93717	93722	93727	93732	93737	93742	93747
866	93752	93757	93762	93767	93772	93777	93782	93787	93792	93797
867	93802	93807	93812	93817	93822	93827	93832	93837	93842	93847
868	93852	93857	93862	93867	93872	93877	93882	93887	93892	93897
869	93902	93907	93912	93917	93922	93927	93932	93937	93942	93947
870	93952	93957	93962	93967	93972	93977	93982	93987	93992	93997
871	94002	94007	94012	94017	94022	94027	94032	94037	94042	94047
872	94052	94057	94062	94067	94072	94077	94082	94086	94091	94096
873	94101	94106	94111	94116	94121	94126	94131	94136	94141	94146
874	94151	94156	94161	94166	94171	94176	94181	94186	94191	94196
875	94201	94206	94211	94216	94221	94226	94231	94236	94240	94245
876	94250	94255	94260	94265	94270	94275	94280	94285	94290	94295
877	94300	94305	94310	94315	94320	94325	94330	94335	94340	94345
878	94349	94354	94359	94364	94369	94374	94379	94384	94389	94394
879	94399	94404	94409	94414	94419	94424	94429	94433	94438	94443
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 8800——9400. Log. 94448——97313.

No.	0	1	2	3	4	5	6	7	8	9
880	94448	94453	94458	94463	94468	94473	94478	94483	94488	94493
881	94498	94503	94507	94512	94517	94522	94527	94532	94537	94542
882	94547	94552	94557	94562	94567	94571	94576	94581	94586	94591
883	94596	94601	94606	94611	94616	94621	94626	94630	94635	94640
884	94645	94650	94655	94660	94665	94670	94675	94680	94685	94689
885	94694	94699	94704	94709	94714	94719	94724	94729	94734	94738
886	94743	94748	94753	94758	94763	94768	94773	94778	94783	94787
887	94792	94797	94802	94807	94812	94817	94822	94827	94832	94836
888	94841	94846	94851	94856	94861	94866	94871	94876	94880	94885
889	94890	94895	94900	94905	94910	94915	94919	94924	94929	94934
890	94939	94944	94949	94954	94959	94963	94968	94973	94978	94983
891	94988	94993	94998	95002	95007	95012	95017	95022	95027	95032
892	95036	95041	95046	95051	95056	95061	95066	95071	95075	95080
893	95085	95090	95095	95100	95105	95109	95114	95119	95124	95129
894	95134	95139	95143	95148	95153	95158	95163	95168	95173	95177
895	95182	95187	95192	95197	95202	95207	95211	95216	95221	95226
896	95231	95236	95240	95245	95250	95255	95260	95265	95270	95274
897	95279	95284	95289	95294	95299	95303	95308	95313	95318	95323
898	95328	95332	95337	95342	95347	95352	95357	95361	95366	95371
899	95376	95381	95386	95390	95395	95400	95405	95410	95415	95419
900	95424	95429	95434	95439	95444	95448	95453	95458	95463	95468
901	95472	95477	95482	95487	95492	95497	95501	95506	95511	95516
902	95521	95525	95530	95535	95540	95545	95550	95554	95559	95564
903	95569	95574	95578	95583	95588	95593	95598	95602	95607	95612
904	95617	95622	95626	95631	95636	95641	95646	95650	95655	95660
905	95665	95670	95674	95679	95684	95689	95694	95698	95703	95708
906	95713	95718	95722	95727	95732	95737	95742	95746	95751	95756
907	95761	95766	95770	95775	95780	95785	95789	95794	95799	95804
908	95809	95813	95818	95823	95828	95832	95837	95842	95847	95852
909	95856	95861	95866	95871	95875	95880	95885	95890	95895	95899
910	95904	95909	95914	95918	95923	95928	95933	95938	95942	95947
911	95952	95957	95961	95966	95971	95976	95980	95985	95990	95995
912	95999	96004	96009	96014	96019	96023	96028	96033	96038	96042
913	96047	96052	96057	96061	96066	96071	96076	96080	96085	96090
914	96095	96099	96104	96109	96114	96118	96123	96128	96133	96137
915	96142	96147	96152	96156	96161	96166	96171	96175	96180	96185
916	96190	96194	96199	96204	96209	96213	96218	96223	96227	96232
917	96237	96242	96246	96251	96256	96261	96265	96270	96275	96280
918	96284	96289	96294	96298	96303	96308	96313	96317	96322	96327
919	96332	96336	96341	96346	96350	96355	96360	96365	96369	96374
920	96379	96384	96388	96393	96398	96402	96407	96412	96417	96421
921	96426	96431	96435	96440	96445	96450	96454	96459	96464	96468
922	96473	96478	96483	96487	96492	96497	96501	96506	96511	96515
923	96520	96525	96530	96534	96539	96544	96548	96553	96558	96562
924	96567	96572	96577	96581	96586	96591	96595	96600	96605	96609
925	96614	96619	96624	96628	96633	96638	96642	96647	96652	96656
926	96661	96666	96670	96675	96680	96685	96689	96694	96699	96703
927	96708	96713	96717	96722	96727	96731	96736	96741	96745	96750
928	96755	96759	96764	96769	96774	96778	96783	96788	96792	96797
929	96802	96806	96811	96816	96820	96825	96830	96834	96839	96844
930	96848	96853	96858	96862	96867	96872	96876	96881	96886	96890
931	96895	96900	96904	96909	96914	96918	96923	96928	96932	96937
932	96942	96946	96951	96956	96960	96965	96970	96974	96979	96984
933	96988	96993	96997	97002	97007	97011	97016	97021	97025	97030
934	97035	97039	97044	97049	97053	97058	97063	97067	97072	97077
935	97081	97086	97090	97095	97100	97104	97109	97114	97118	97123
936	97128	97132	97137	97142	97146	97151	97155	97160	97165	97169
937	97174	97179	97183	97188	97192	97197	97202	97206	97211	97216
938	97220	97225	97230	97234	97239	97243	97248	97253	97257	97262
939	97267	97271	97276	97280	97285	97290	97294	97299	97304	97308
No.	0	1	2	3	4	5	6	7	8	9

TABLE XXVI.

LOGARITHMS OF NUMBERS.

No. 9400——10000. Log. 97313——99996.

No.	0	1	2	3	4	5	6	7	8	9
940	97313	97317	97322	97327	97331	97336	97340	97345	97350	97354
941	97359	97364	97368	97373	97377	97382	97387	97391	97396	97400
942	97405	97410	97414	97419	97424	97428	97433	97437	97442	97447
943	97451	97456	97460	97465	97470	97474	97479	97483	97488	97493
944	97497	97502	97506	97511	97516	97520	97525	97529	97534	97539
945	97543	97548	97552	97557	97562	97566	97571	97575	97580	97585
946	97589	97594	97598	97603	97607	97612	97617	97621	97626	97630
947	97635	97640	97644	97649	97653	97658	97663	97667	97672	97676
948	97681	97685	97690	97695	97699	97704	97708	97713	97717	97722
949	97727	97731	97736	97740	97745	97749	97754	97759	97763	97768
950	97772	97777	97782	97786	97791	97795	97800	97804	97809	97813
951	97818	97823	97827	97832	97836	97841	97845	97850	97855	97859
952	97864	97868	97873	97877	97882	97886	97891	97896	97900	97905
953	97909	97914	97918	97923	97928	97932	97937	97941	97946	97950
954	97955	97959	97964	97968	97973	97978	97982	97987	97991	97996
955	98000	98005	98009	98014	98019	98023	98028	98032	98037	98041
956	98046	98050	98055	98059	98064	98068	98073	98078	98082	98087
957	98091	98096	98100	98105	98109	98114	98118	98123	98127	98132
958	98137	98141	98146	98150	98155	98159	98164	98168	98173	98177
959	98182	98186	98191	98195	98200	98204	98209	98214	98218	98223
960	98227	98232	98236	98241	98245	98250	98254	98259	98263	98268
961	98272	98277	98281	98286	98290	98295	98299	98304	98308	98313
962	98318	98322	98327	98331	98336	98340	98345	98349	98354	98358
963	98363	98367	98372	98376	98381	98385	98390	98394	98399	98403
964	98408	98412	98417	98421	98426	98430	98435	98439	98444	98448
965	98453	98457	98462	98466	98471	98475	98480	98484	98489	98493
966	98498	98502	98507	98511	98516	98520	98525	98529	98534	98538
967	98543	98547	98552	98556	98561	98565	98570	98574	98579	98583
968	98588	98592	98597	98601	98605	98610	98614	98619	98623	98628
969	98632	98637	98641	98646	98650	98655	98659	98664	98668	98673
970	98677	98682	98686	98691	98695	98700	98704	98709	98713	98717
971	98722	98726	98731	98735	98740	98744	98749	98753	98758	98762
972	98767	98771	98776	98780	98784	98789	98793	98798	98802	98807
973	98811	98816	98820	98825	98829	98834	98838	98843	98847	98851
974	98856	98860	98865	98869	98874	98878	98883	98887	98892	98896
975	98900	98905	98909	98914	98918	98923	98927	98932	98936	98941
976	98945	98949	98954	98958	98963	98967	98972	98976	98981	98985
977	98989	98994	98998	99003	99007	99012	99016	99021	99025	99029
978	99034	99038	99043	99047	99052	99056	99061	99065	99069	99074
979	99078	99083	99087	99092	99096	99100	99105	99109	99114	99118
980	99123	99127	99131	99136	99140	99145	99149	99154	99158	99162
981	99167	99171	99176	99180	99185	99189	99193	99198	99202	99207
982	99211	99216	99220	99224	99229	99233	99238	99242	99247	99251
983	99255	99260	99264	99269	99273	99277	99282	99286	99291	99295
984	99300	99304	99308	99313	99317	99322	99326	99330	99335	99339
985	99344	99348	99352	99357	99361	99366	99370	99374	99379	99383
986	99388	99392	99396	99401	99405	99410	99414	99419	99423	99427
987	99432	99436	99441	99445	99449	99454	99458	99463	99467	99471
988	99476	99480	99484	99489	99493	99498	99502	99506	99511	99515
989	99520	99524	99528	99533	99537	99542	99546	99550	99555	99559
990	99564	99568	99572	99577	99581	99585	99590	99594	99599	99603
991	99607	99612	99616	99621	99625	99629	99634	99638	99642	99647
992	99651	99656	99660	99664	99669	99673	99677	99682	99686	99691
993	99695	99699	99704	99708	99712	99717	99721	99726	99730	99734
994	99739	99743	99747	99752	99756	99760	99765	99769	99774	99778
995	99782	99787	99791	99795	99800	99804	99808	99813	99817	99822
996	99826	99830	99835	99839	99843	99848	99852	99856	99861	99865
997	99870	99874	99878	99883	99887	99891	99896	99900	99904	99909
998	99913	99917	99922	99926	99930	99935	99939	99944	99948	99952
999	99957	99961	99965	99970	99974	99978	99983	99987	99991	99996
No.	0	1	2	3	4	5	6	7	8	9

Log. Sines, Tangents and Secants.

0 Deg. Degs. 179.

M.	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M.
0	12 0 0	0 0 0	Inf. Neg.	10.00000	Inf. Neg.	Infinite.	10.00000	Infinite.	60
1	11 59 52	0 8	6.46373	00000	6.46373	13.53627	00000	13.53627	59
2	59 44	0 16	76476	00000	76476	23524	00000	23524	58
3	59 36	0 24	94085	00000	94085	05915	00000	05915	57
4	59 28	0 32	7.06579	00000	7.06579	12.93421	00000	12.93421	56
5	11 59 20	0 0 40	7.16270	10.00000	7.16270	12.83730	10.00000	12.83730	55
6	59 12	0 48	24188	00000	24188	75812	00000	75812	54
7	59 4	0 56	30882	00000	30882	69118	00000	69118	53
8	58 56	1 4	36682	00000	36682	63318	00000	63318	52
9	58 48	1 12	41797	00000	41797	58203	00000	58203	51
10	11 58 40	0 1 20	7.46373	10.00000	7.46373	12.53627	10.00000	12.53627	50
11	58 32	1 28	50512	00000	50512	49488	00000	49488	49
12	58 24	1 36	54291	00000	54291	45709	00000	45709	48
13	58 16	1 44	57767	00000	57767	42233	00000	42233	47
14	58 8	1 52	60985	00000	60986	39014	00000	39015	46
15	11 58 0	0 2 0	7.63982	10.00000	7.63982	12.36018	10.00000	12.36018	45
16	57 52	2 8	66784	00000	66785	33215	00000	33216	44
17	57 44	2 16	69417	9.99999	69418	30582	00001	30583	43
18	57 36	2 24	71900	99999	71900	28100	00001	28100	42
19	57 28	2 32	74248	99999	74248	25752	00001	25752	41
20	11 57 20	0 2 40	7.76475	9.99999	7.76476	12.23524	10.00001	12.23525	40
21	57 12	2 48	78594	99999	78595	21405	00001	21406	39
22	57 4	2 56	80615	99999	80615	19385	00001	19385	38
23	56 56	3 4	82545	99999	82546	17454	00001	17455	37
24	56 48	3 12	84393	99999	84394	15606	00001	15607	36
25	11 56 40	0 3 20	7.86166	9.99999	7.86167	12.13833	10.00001	12.13834	35
26	56 32	3 28	87870	99999	87871	12129	00001	12130	34
27	56 24	3 36	89509	99999	89510	10490	00001	10491	33
28	56 16	3 44	91088	99999	91089	08911	00001	08912	32
29	56 8	3 52	92612	99998	92613	07387	00002	07388	31
30	11 56 0	0 4 0	7.94084	9.99998	7.94086	12.05914	10.00002	12.05916	30
31	55 52	4 8	95508	99998	95510	04490	00002	04492	29
32	55 44	4 16	96887	99998	96889	03111	00002	03113	28
33	55 36	4 24	98223	99998	98225	01775	00002	01777	27
34	55 28	4 32	99520	99998	99522	00478	00002	00480	26
35	11 55 20	0 4 40	8.00779	9.99998	8.00781	11.99219	10.00002	11.99221	25
36	55 12	4 48	02002	99998	02004	97996	00002	97998	24
37	55 4	4 56	03192	99997	03194	96806	00003	96808	23
38	54 56	5 4	04350	99997	04353	95647	00003	95650	22
39	54 48	5 12	05478	99997	05481	94519	00003	94522	21
40	11 54 40	0 5 20	8.06578	9.99997	8.06581	11.93419	10.00003	11.93422	20
41	54 32	5 28	07650	99997	07653	92347	00003	92350	19
42	54 24	5 36	08696	99997	08700	91300	00003	91304	18
43	54 16	5 44	09718	99997	09722	90278	00003	90282	17
44	54 8	5 52	10717	99996	10720	89280	00004	89283	16
45	11 54 0	0 6 0	8.11693	9.99996	8.11696	11.88304	10.00004	11.88307	15
46	53 52	6 8	12647	99996	12651	87349	00004	87353	14
47	53 44	6 16	13581	99996	13585	86415	00004	86419	13
48	53 36	6 24	14495	99996	14500	85500	00004	85505	12
49	53 28	6 32	15391	99996	15395	84605	00004	84609	11
50	11 53 20	0 6 40	8.16268	9.99995	8.16273	11.83727	10.00005	11.83732	10
51	53 12	6 48	17128	99995	17133	82867	00005	82872	9
52	53 4	6 56	17971	99995	17976	82024	00005	82029	8
53	52 56	7 4	18798	99995	18804	81196	00005	81202	7
54	52 48	7 12	19610	99995	19616	80384	00005	80390	6
55	11 52 40	0 7 20	8.20407	9.99994	8.20413	11.79587	10.00006	11.79593	5
56	52 32	7 28	21189	99994	21195	78805	00006	78811	4
57	52 24	7 36	21958	99994	21964	78036	00006	78042	3
58	52 16	7 44	22713	99994	22720	77280	00006	77287	2
59	52 8	7 52	23456	99994	23462	76538	00006	76544	1
60	52 0	8 0	24186	99993	24192	75808	00007	75814	0
M.	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M.

90 Degs. Degs. 89.

Log. Sines, Tangents and Secants.

1 Deg. Degs. 178.

M.	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M.
0	11 52 0	0 8 0	8.24186	9.99993	8.24192	11.75808	10.00007	11.75814	60
1	51 52	8 8	24903	99993	24910	75090	00007	75097	59
2	51 44	8 16	25609	99993	25616	74384	00007	74391	58
3	51 36	8 24	26304	99993	26312	73688	00007	73696	57
4	51 28	8 32	26988	99992	26996	73004	00008	73012	56
5	11 51 20	0 8 40	8.27661	9.99992	8.27669	11.72331	10.00008	11.72339	55
6	51 12	8 48	28324	99992	28332	71668	00008	71676	54
7	51 4	8 56	28977	99992	28986	71014	00008	71023	53
8	50 56	9 4	29621	99992	29629	70371	00008	70379	52
9	50 48	9 12	30255	99991	30263	69737	00009	69745	51
10	11 50 40	0 9 20	8.30879	9.99991	8.30888	11.69112	10.00009	11.69121	50
11	50 32	9 28	31495	99991	31505	68495	00009	68505	49
12	50 24	9 36	32103	99990	32112	67888	00010	67897	48
13	50 16	9 44	32702	99990	32711	67289	00010	67298	47
14	50 8	9 52	33292	99990	33302	66698	00010	66708	46
15	11 50 0	0 10 0	8.33875	9.99990	8.33886	11.66114	10.00010	11.66125	45
16	49 52	10 8	34450	99989	34461	65539	00011	65550	44
17	49 44	10 16	35018	99989	35029	64971	00011	64982	43
18	49 36	10 24	35578	99989	35590	64410	00011	64422	42
19	49 28	10 32	36131	99989	36143	63857	00011	63869	41
20	11 49 20	0 10 40	8.36678	9.99988	8.36689	11.63311	10.00012	11.63322	40
21	49 12	10 48	37217	99988	37229	62771	00012	62783	39
22	49 4	10 56	37750	99988	37762	62238	00012	62250	38
23	48 56	11 4	38276	99987	38289	61711	00013	61724	37
24	48 48	11 12	38796	99987	38809	61191	00013	61204	36
25	11 48 40	0 11 20	8.39310	9.99987	8.39323	11.60677	10.00013	11.60690	35
26	48 32	11 28	39818	99986	39832	60168	00014	60182	34
27	48 24	11 36	40320	99986	40334	59666	00014	59680	33
28	48 16	11 44	40816	99986	40830	59170	00014	59184	32
29	48 8	11 52	41307	99985	41321	58679	00015	58693	31
30	11 48 0	0 12 0	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
31	47 52	12 8	42272	99985	42287	57713	00015	57728	29
32	47 44	12 16	42746	99984	42762	57238	00016	57254	28
33	47 36	12 24	43216	99984	43232	56768	00016	56784	27
34	47 28	12 32	43680	99984	43696	56304	00016	56320	26
35	11 47 20	0 12 40	8.44139	9.99983	8.44156	11.55844	10.00017	11.55861	25
36	47 12	12 48	44594	99983	44611	55389	00017	55406	24
37	47 4	12 56	45044	99983	45061	54939	00017	54956	23
38	46 56	13 4	45489	99982	45507	54493	00018	54511	22
39	46 48	13 12	45930	99982	45948	54052	00018	54070	21
40	11 46 40	0 13 20	8.46366	9.99982	8.46385	11.53615	10.00018	11.53634	20
41	46 32	13 28	46799	99981	46817	53183	00019	53201	19
42	46 24	13 36	47226	99981	47245	52755	00019	52774	18
43	46 16	13 44	47650	99981	47669	52331	00019	52350	17
44	46 8	13 52	48069	99980	48089	51911	00020	51931	16
45	11 46 0	0 14 0	8.48485	9.99980	8.48505	11.51495	10.00020	11.51515	15
46	45 52	14 8	48896	99979	48917	51083	00021	51104	14
47	45 44	14 16	49304	99979	49325	50675	00021	50696	13
48	45 36	14 24	49708	99979	49729	50271	00021	50292	12
49	45 28	14 32	50108	99978	50130	49870	00022	49892	11
50	11 45 20	0 14 40	8.50504	9.99978	8.50527	11.49473	10.00022	11.49496	10
51	45 12	14 48	50897	99977	50920	49080	00023	49103	9
52	45 4	14 56	51287	99977	51310	48690	00023	48713	8
53	44 56	15 4	51673	99977	51696	48304	00023	48327	7
54	44 48	15 12	52055	99976	52079	47921	00024	47945	6
55	11 44 40	0 15 20	8.52434	9.99976	8.52459	11.47541	10.00024	11.47566	5
56	44 32	15 28	52810	99975	52835	47165	00025	47190	4
57	44 24	15 36	53183	99975	53208	46792	00025	46817	3
58	44 16	15 44	53552	99974	53578	46422	00026	46448	2
59	44 8	15 52	53919	99974	53945	46055	00026	46081	1
60	44 0	16 0	54282	99974	54308	45692	00026	45718	0
M.	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant	M.

91 Degs. Degs. 88.

TABLE XXVII.

Log. Sines, Tangents and Secants.

2 Degs. | Degs. 177.

M.	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M.
0	11 44 0	0 16 0	8.54282	9.99974	8.54308	11.45692	10.00026	11.45718	60
1	43 52	16 8	54642	99973	54669	45331	00027	45358	59
2	43 44	16 16	54999	99973	55027	44973	00027	45001	58
3	43 36	16 24	55354	99972	55382	44618	00028	44646	57
4	43 28	16 32	55705	99972	55734	44266	00028	44295	56
5	11 43 20	0 16 40	8.56054	9.99971	8.56083	11.43917	10.00029	11.43946	55
6	43 12	16 48	56400	99971	56429	43571	00029	43600	54
7	43 4	16 56	56743	99970	56773	43227	00030	43257	53
8	42 56	17 4	57084	99970	57114	42886	00030	42916	52
9	42 48	17 12	57421	99969	57452	42548	00031	42579	51
10	11 42 40	0 17 20	8.57757	9.99969	8.57788	11.42212	10.00031	11.42243	50
11	42 32	17 28	58089	99968	58121	41879	00032	41911	49
12	42 24	17 36	58419	99968	58451	41549	00032	41581	48
13	42 16	17 44	58747	99967	58779	41221	00033	41253	47
14	42 8	17 52	59072	99967	59105	40895	00033	40928	46
15	11 42 0	0 18 0	8.59395	9.99967	8.59428	11.40572	10.00033	11.40605	45
16	41 52	18 8	59715	99966	59749	40251	00034	40285	44
17	41 44	18 16	60033	99966	60068	39932	00034	39967	43
18	41 36	18 24	60349	99965	60384	39616	00035	39651	42
19	41 28	18 32	60662	99964	60698	39302	00036	39338	41
20	11 41 20	0 18 40	8.60973	9.99964	8.61009	11.38991	10.00036	11.39027	40
21	41 12	18 48	61282	99963	61319	38681	00037	38718	39
22	41 4	18 56	61589	99963	61626	38374	00037	38411	38
23	40 56	19 4	61894	99962	61931	38069	00038	38106	37
24	40 48	19 12	62196	99962	62234	37766	00038	37804	36
25	11 40 40	0 19 20	8.62497	9.99961	8.62535	11.37465	10.00039	11.37503	35
26	40 32	19 28	62795	99961	62834	37166	00039	37205	34
27	40 24	19 36	63091	99960	63131	36869	00040	36909	33
28	40 16	19 44	63385	99960	63426	36574	00040	36615	32
29	40 8	19 52	63678	99959	63718	36282	00041	36322	31
30	11 40 0	0 20 0	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
31	39 52	20 8	64256	99958	64298	35702	00042	35744	29
32	39 44	20 16	64543	99958	64585	35415	00042	35457	28
33	39 36	20 24	64827	99957	64870	35130	00043	35173	27
34	39 28	20 32	65110	99956	65154	34846	00044	34890	26
35	11 39 20	0 20 40	8.65391	9.99956	8.65435	11.34565	10.00044	11.34609	25
36	39 12	20 48	65670	99955	65715	34285	00045	34330	24
37	39 4	20 56	65947	99955	65993	34007	00045	34053	23
38	38 56	21 4	66223	99954	66269	33731	00046	33777	22
39	38 48	21 12	66497	99954	66543	33457	00046	33503	21
40	11 38 40	0 21 20	8.66769	9.99953	8.66816	11.33184	10.00047	11.33231	20
41	38 32	21 28	67039	99952	67087	32913	00048	32961	19
42	38 24	21 36	67308	99952	67356	32644	00048	32692	18
43	38 16	21 44	67575	99951	67624	32376	00049	32425	17
44	38 8	21 52	67841	99951	67890	32110	00049	32159	16
45	11 38 0	0 22 0	8.68104	9.99950	8.68154	11.31846	10.00050	11.31896	15
46	37 52	22 8	68367	99949	68417	31583	00051	31633	14
47	37 44	22 16	68627	99949	68678	31322	00051	31373	13
48	37 36	22 24	68886	99948	68938	31062	00052	31114	12
49	37 28	22 32	69144	99948	69196	30804	00052	30856	11
50	11 37 20	0 22 40	8.69400	9.99947	8.69453	11.30547	10.00053	11.30600	10
51	37 12	22 48	69654	99946	69708	30292	00054	30346	9
52	37 4	22 56	69907	99946	69962	30038	00054	30093	8
53	36 56	23 4	70159	99945	70214	29786	00055	29841	7
54	36 48	23 12	70409	99944	70465	29535	00056	29591	6
55	11 36 40	0 23 20	8.70658	9.99944	8.70714	11.29286	10.00056	11.29342	5
56	36 32	23 28	70905	99943	70962	29038	00057	29095	4
57	36 24	23 36	71151	99942	71208	28792	00058	28849	3
58	36 16	23 44	71395	99942	71453	28547	00058	28605	2
59	36 8	23 52	71638	99941	71697	28303	00059	28362	1
60	36 0	24 0	71880	99940	71940	28060	00060	28120	0
M.	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M.

2 Degs. | Degs. 87

TABLE XXVII.

Log. Sines, Tangents and Secants.

3 Degs. Degs. 176.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	11 36 0	0 24 0	8.71880	9.99940	8.71940	11.28060	10.00060	11.28120	60
1	35 52	24 8	72120	99940	72181	27819	00060	27880	59
2	35 44	24 16	72359	99939	72420	27580	00061	27641	58
3	35 36	24 24	72597	99938	72659	27341	00062	27403	57
4	35 28	24 32	72834	99938	72896	27104	00062	27166	56
5	11 35 20	0 24 40	8.73069	9.99937	8.73132	11.26868	10.00063	11.26931	55
6	35 12	24 48	73303	99936	73366	26634	00064	26697	54
7	35 4	24 56	73535	99936	73600	26400	00064	26465	53
8	34 56	25 4	73767	99935	73832	26168	00065	26233	52
9	34 48	25 12	73997	99934	74063	25937	00066	26003	51
10	11 34 40	0 25 20	8.74226	9.99934	8.74292	11.25708	10.00066	11.25774	50
11	34 32	25 28	74454	99933	74521	25479	00067	25546	49
12	34 24	25 36	74680	99932	74748	25252	00068	25320	48
13	34 16	25 44	74906	99932	74974	25026	00068	25094	47
14	34 8	25 52	75130	99931	75199	24801	00069	24870	46
15	11 34 0	0 26 0	8.75353	9.99930	8.75423	11.24577	10.00070	11.24647	45
16	33 52	26 8	75575	99929	75645	24355	00071	24425	44
17	33 44	26 16	75795	99929	75867	24133	00071	24205	43
18	33 36	26 24	76015	99928	76087	23913	00072	23985	42
19	33 28	26 32	76234	99927	76306	23694	00073	23766	41
20	11 33 20	0 26 40	8.76451	9.99926	8.76525	11.23475	10.00074	11.23549	40
21	33 12	26 48	76667	99926	76742	23258	00074	23333	39
22	33 4	26 56	76883	99925	76958	23042	00075	23117	38
23	32 56	27 4	77097	99924	77173	22827	00076	22903	37
24	32 48	27 12	77310	99923	77387	22613	00077	22690	36
25	11 32 40	0 27 20	8.77522	9.99923	8.77600	11.22400	10.00077	11.22478	35
26	32 32	27 28	77733	99922	77811	22189	00078	22267	34
27	32 24	27 36	77943	99921	78022	21978	00079	22057	33
28	32 16	27 44	78152	99920	78232	21768	00080	21848	32
29	32 8	27 52	78360	99920	78441	21559	00080	21640	31
30	11 32 0	0 28 0	8.78568	9.99919	8.78649	11.21351	10.00081	11.21432	30
31	31 52	28 8	78774	99918	78855	21145	00082	21226	29
32	31 44	28 16	78979	99917	79061	20939	00083	21021	28
33	31 36	28 24	79183	99917	79266	20734	00083	20817	27
34	31 28	28 32	79386	99916	79470	20530	00084	20614	26
35	11 31 20	0 28 40	8.79588	9.99915	8.79673	11.20327	10.00085	11.20412	25
36	31 12	28 48	79789	99914	79875	20125	00086	20211	24
37	31 4	28 56	79990	99913	80076	19924	00087	20010	23
38	30 56	29 4	80189	99913	80277	19723	00087	19811	22
39	30 48	29 12	80388	99912	80476	19524	00088	19612	21
40	11 30 40	0 29 20	8.80585	9.99911	8.80674	11.19326	10.00089	11.19415	20
41	30 32	29 28	80782	99910	80872	19128	00090	19218	19
42	30 24	29 36	80978	99909	81068	18932	00091	19022	18
43	30 16	29 44	81173	99909	81264	18736	00091	18827	17
44	30 8	29 52	81367	99908	81459	18541	00092	18633	16
45	11 30 0	0 30 0	8.81560	9.99907	8.81653	11.18347	10.00093	11.18440	15
46	29 52	30 8	81752	99906	81846	18154	00094	18248	14
47	29 44	30 16	81944	99905	82038	17962	00095	18056	13
48	29 36	30 24	82134	99904	82230	17770	00096	17866	12
49	29 28	30 32	82324	99904	82420	17580	00096	17676	11
50	11 29 20	0 30 40	8.82513	9.99903	8.82610	11.17390	10.00097	11.17487	10
51	29 12	30 48	82701	99902	82799	17201	00098	17299	9
52	29 4	30 56	82888	99901	82987	17013	00099	17112	8
53	28 56	31 4	83075	99900	83175	16825	00100	16925	7
54	28 48	31 12	83261	99899	83361	16639	00101	16739	6
55	11 28 40	0 31 20	8.83446	9.99898	8.83547	11.16453	10.00102	11.16554	5
56	28 32	31 28	83630	99898	83732	16268	00102	16370	4
57	28 24	31 36	83813	99897	83916	16084	00103	16187	3
58	28 16	31 44	83996	99896	84100	15900	00104	16004	2
59	28 8	31 52	84177	99895	84282	15718	00105	15823	1
60	28 0	32 0	84358	99894	84464	15536	00106	15642	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang	Tangent.	Co-secant	Secant.	M

93 Degs. Degs. 86

Log. Sines, Tangents and Secants.

4 Degs. Degs. 175.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 28 0	0 32 0	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
1	27 52	32 8	84539	99893	84646	15354	00107	15461	59
2	27 44	32 16	84718	99892	85826	15174	00108	15282	58
3	27 36	32 24	84897	99891	85006	14994	00109	15103	57
4	27 28	32 32	85075	99891	85185	14815	00109	14925	56
5	11 27 20	0 32 40	8.85252	9.99890	8.85363	11.14637	10.00110	11.14748	55
6	27 12	32 48	85429	99889	85540	14460	00111	14571	54
7	27 4	32 56	85605	99888	85717	14283	00112	14395	53
8	26 56	33 4	85780	99887	85893	14107	00113	14220	52
9	26 48	33 12	85955	99886	86069	13931	00114	14045	51
10	11 26 40	0 33 20	8.86128	9.99885	8.86243	11.13757	10.00115	11.13872	50
11	26 32	33 28	86301	99884	86417	13583	00116	13699	49
12	26 24	33 36	86474	99883	86591	13409	00117	13526	48
13	26 16	33 44	86645	99882	86763	13237	00118	13355	47
14	26 8	33 52	86816	99881	86935	13065	00119	13184	46
15	11 26 0	0 34 0	8.86987	9.99880	8.87106	11.12894	10.00120	11.13013	45
16	25 52	34 8	87156	99879	87277	12723	00121	12844	44
17	25 44	34 16	87325	99879	87447	12553	00121	12675	43
18	25 36	34 24	87494	99878	87616	12384	00122	12506	42
19	25 28	34 32	87661	99877	87785	12215	00123	12339	41
20	11 25 20	0 34 40	8.87829	9.99876	8.87953	11.12047	10.00124	11.12171	40
21	25 12	34 48	87995	99875	88120	11880	00125	12005	39
22	25 4	34 56	88161	99874	88287	11713	00126	11839	38
23	24 56	35 4	88326	99873	88453	11547	00127	11674	37
24	24 48	35 12	88490	99872	88618	11382	00128	11510	36
25	11 24 40	0 35 20	8.88654	9.99871	8.88783	11.11217	10.00129	11.11346	35
26	24 32	35 28	88817	99870	88948	11052	00130	11183	34
27	24 24	35 36	88980	99869	89111	10889	00131	11020	33
28	24 16	35 44	89142	99868	89274	10726	00132	10858	32
29	24 8	35 52	89304	99867	89437	10563	00133	10696	31
30	11 24 0	0 36 0	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
31	23 52	36 8	89625	99865	89760	10240	00135	10375	29
32	23 44	36 16	89784	99864	89920	10080	00136	10216	28
33	23 36	36 24	89943	99863	90080	09920	00137	10057	27
34	23 28	36 32	90102	99862	90240	09760	00138	09898	26
35	11 23 20	0 36 40	8.90260	9.99861	8.90399	11.09601	10.00139	11.09740	25
36	23 12	36 48	90417	99860	90557	09443	00140	09583	24
37	23 4	36 56	90574	99859	90715	09285	00141	09426	23
38	22 56	37 4	90730	99858	90872	09128	00142	09270	22
39	22 48	37 12	90885	99857	91029	08971	00143	09115	21
40	11 22 40	0 37 20	8.91040	9.99856	8.91185	11.08815	10.00144	11.08960	20
41	22 32	37 28	91195	99855	91340	08660	00145	08805	19
42	22 24	37 36	91349	99854	91495	08505	00146	08651	18
43	22 16	37 44	91502	99853	91650	08350	00147	08498	17
44	22 8	37 52	91655	99852	91803	08197	00148	08345	16
45	11 22 0	0 38 0	8.91807	9.99851	8.91957	11 08043	10.00149	11.08193	15
46	21 52	38 8	91959	99850	92110	07890	00150	08041	14
47	21 44	38 16	92110	99848	92262	07738	00152	07890	13
48	21 36	38 24	92261	99847	92414	07586	00153	07739	12
49	21 28	38 32	92411	99846	92565	07435	00154	07589	11
50	11 21 20	0 38 40	8.92561	9.99845	8.92716	11.07284	10.00155	11.07439	10
51	21 12	38 43	92710	99844	92866	07134	00156	07290	9
52	21 4	38 56	92859	99843	93016	06984	00157	07141	8
53	20 56	39 4	93007	99842	93165	06835	00158	06993	7
54	20 48	39 12	93154	99841	93313	06687	00159	06846	6
55	11 20 40	0 39 20	8.93301	9.99840	8.93462	11.06538	10.00160	11.06699	5
56	20 32	39 28	93448	99839	93609	06391	00161	06552	4
57	20 24	39 36	93594	99838	93756	06244	00162	06406	3
58	20 16	39 44	93740	99837	93903	06097	00163	06260	2
59	20 8	39 52	93885	99836	94049	05951	00164	06115	1
60	20 0	40 0	94030	99834	94195	05805	00166	05970	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

94 Degs. Degs. 85.

Log. Sines, Tangents and Secants.

5 Degs. Degs. 174.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 20 0	0 40 0	8.94030	9.99834	8.94195	11.05805	10.00166	11.05970	60
1	19 52	40 8	94174	99833	94340	05660	00167	05826	59
2	19 44	40 16	94317	99832	94485	05515	00168	05683	58
3	19 36	40 24	94461	99831	94630	05370	00169	05539	57
4	19 28	40 32	94603	99830	94773	05227	00170	05397	56
5	11 19 20	0 40 40	8.94746	9.99829	8.94917	11.05083	10.00171	11.05254	55
6	19 12	40 48	94887	99828	95060	04940	00172	05113	54
7	19 4	40 56	95029	99827	95202	04798	00173	04971	53
8	18 56	41 4	95170	99825	95344	04656	00175	04830	52
9	18 48	41 12	95310	99824	95486	04514	00176	04690	51
10	11 18 40	0 41 20	8.95450	9.99823	8.95627	11.04373	10.00177	11.04550	50
11	18 32	41 28	95589	99822	95767	04233	00178	04411	49
12	18 24	41 36	95728	99821	95908	04092	00179	04272	48
13	18 16	41 44	95867	99820	96047	03953	00180	04133	47
14	18 8	41 52	96005	99819	96187	03813	00181	03995	46
15	11 18 0	0 42 0	8.96143	9.99817	8.96325	11.03675	10.00183	11.03857	45
16	17 52	42 8	96280	99816	96464	03536	00184	03720	44
17	17 44	42 16	96417	99815	96602	03398	00185	03583	43
18	17 36	42 24	96553	99814	96739	03261	00186	03447	42
19	17 28	42 32	96689	99813	96877	03123	00187	03311	41
20	11 17 20	0 42 40	8.96825	9.99812	8.97013	11.02987	10.00188	11.03175	40
21	17 12	42 48	96960	99810	97150	02850	00190	03040	39
22	17 4	42 56	97095	99809	97285	02715	00191	02905	38
23	16 56	43 4	97229	99808	97421	02579	00192	02771	37
24	16 48	43 12	97363	99807	97556	02444	00193	02637	36
25	11 16 40	0 43 20	8.97496	9.99806	8.97691	11.02309	10.00194	11.02504	35
26	16 32	43 28	97629	99804	97825	02175	00196	02371	34
27	16 24	43 36	97762	99803	97959	02041	00197	02238	33
28	16 16	43 44	97894	99802	98092	01908	00198	02106	32
29	16 8	43 52	98026	99801	98225	01775	00199	01974	31
30	11 16 0	0 44 0	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
31	15 52	44 8	98288	99798	98490	01510	00202	01712	29
32	15 44	44 16	98419	99797	98622	01378	00203	01581	28
33	15 36	44 24	98549	99796	98753	01247	00204	01451	27
34	15 28	44 32	98679	99795	98884	01116	00205	01321	26
35	11 15 20	0 44 40	8.98808	9.99793	8.99015	11.00985	10.00207	11.01192	25
36	15 12	44 48	98937	99792	99145	00855	00208	01063	24
37	15 4	44 56	99066	99791	99275	00725	00209	00934	23
38	14 56	45 4	99194	99790	99405	00595	00210	00806	22
39	14 48	45 12	99322	99788	99534	00466	00212	00678	21
40	11 14 40	0 45 20	8.99450	9.99787	8.99662	11.00338	10.00213	11.00550	20
41	14 32	45 28	99577	99786	99791	00209	00214	00423	19
42	14 24	45 36	99704	99785	99919	00081	00215	00296	18
43	14 16	45 44	99830	99783	9.00046	10.99954	00217	00170	17
44	14 8	45 52	99956	99782	00174	99826	00218	00044	16
45	11 14 0	0 46 0	9.00082	9.99781	9.00301	10.99699	10.00219	10.99918	15
46	13 52	46 8	00207	99780	00427	99573	00220	99793	14
47	13 44	46 16	00332	99778	00553	99447	00222	99668	13
48	13 36	46 24	00456	99777	00679	99321	00223	99544	12
49	13 28	46 32	00581	99776	00805	99195	00224	99419	11
50	11 13 20	0 46 40	9.00704	9.99775	9.00930	10.99070	10.00225	10.99296	10
51	13 12	46 48	00828	99773	01055	98945	00227	99172	9
52	13 4	46 56	00951	99772	01179	98821	00228	99049	8
53	12 56	47 4	01074	99771	01303	98697	00229	98926	7
54	12 48	47 12	01196	99769	01427	98573	00231	98804	6
55	11 12 40	0 47 20	9.01318	9.99768	9.01550	10.98450	10.00232	10.98682	5
56	12 32	47 28	01440	99767	01673	98327	00233	98560	4
57	12 24	47 36	01561	99765	01796	98204	00235	98439	3
58	12 16	47 44	01682	99764	01918	98082	00236	98318	2
59	12 8	47 52	01803	99763	02040	97960	00237	98197	1
60	12 0	48 0	01923	99761	02162	97838	00239	98077	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

95 Degs. Degs. 84

TABLE XXVII.

Log. Sines, Tangents and Secants.

6 Degs. | Degs. 173.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	11 12 0	0 48 0	9.01923	9.99761	9.02162	10.97838	10.00239	10.98077	60
1	11 52	48 8	02043	99760	02283	97717	00240	97957	59
2	11 44	48 16	02163	99759	02404	97596	00241	97837	58
3	11 36	48 24	02283	99757	02525	97475	00243	97717	57
4	11 28	48 32	02402	99756	02645	97355	00244	97598	56
5	11 11 20	0 48 40	9.02520	9.99755	9.02766	10.97234	10.00245	10.97480	55
6	11 12	48 48	02639	99753	02885	97115	00247	97361	54
7	11 4	48 56	02757	99752	03005	96995	00248	97243	53
8	10 56	49 4	02874	99751	03124	96876	00249	97126	52
9	10 48	49 12	02992	99749	03242	96758	00251	97008	51
10	11 10 40	0 49 20	9.03109	9.99748	9.03361	10.96639	10.00252	10.96891	50
11	10 32	49 28	03226	99747	03479	96521	00253	96774	49
12	10 24	49 36	03342	99745	03597	96403	00255	96658	48
13	10 16	49 44	03458	99744	03714	96286	00256	96542	47
14	10 8	49 52	03574	99742	03832	96168	00258	96426	46
15	11 10 0	0 50 0	9.03690	9.99741	9.03948	10.96052	10.00259	10.96310	45
16	9 52	50 8	03805	99740	04065	95935	00260	96195	44
17	9 44	50 16	03920	99738	04181	95819	00262	96080	43
18	9 36	50 24	04034	99737	04297	95703	00263	95966	42
19	9 28	50 32	04149	99736	04413	95587	00264	95851	41
20	11 9 20	0 50 40	9.04262	9.99734	9.04528	10.95472	10.00266	10.95738	40
21	9 12	50 48	04376	99733	04643	95357	00267	95624	39
22	9 4	50 56	04490	99731	04758	95242	00269	95510	38
23	8 56	51 4	04603	99730	04873	95127	00270	95397	37
24	8 48	51 12	04715	99728	04987	95013	00272	95285	36
25	11 8 40	0 51 20	9.04828	9.99727	9.05101	10.94899	10.00273	10.95172	35
26	8 32	51 28	04940	99726	05214	94786	00274	95060	34
27	8 24	51 36	05052	99724	05328	94672	00276	94948	33
28	8 16	51 44	05164	99723	05441	94559	00277	94836	32
29	8 8	51 52	05275	99721	05553	94447	00279	94725	31
30	11 8 0	0 52 0	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
31	7 52	52 8	05497	99718	05778	94222	00282	94503	29
32	7 44	52 16	05607	99717	05890	94110	00283	94393	28
33	7 36	52 24	05717	99716	06002	93998	00234	94283	27
34	7 28	52 32	05827	99714	06113	93887	00286	94173	26
35	11 7 20	0 52 40	9.05937	9.99713	9.06224	10.93776	10.00287	10.94063	25
36	7 12	52 48	06046	99711	06335	93665	00289	93954	24
37	7 4	52 56	06155	99710	06445	93555	00290	93845	23
38	6 56	53 4	06264	99708	06556	93444	00292	93736	22
39	6 48	53 12	06372	99707	06666	93334	00293	93628	21
40	11 6 40	0 53 20	9.06481	9.99705	9.06775	10.93225	10.00295	10.93519	20
41	6 32	53 28	06589	99704	06885	93115	00296	93411	19
42	6 24	53 36	06696	99702	06994	93006	00298	93304	18
43	6 16	53 44	06804	99701	07103	92897	00299	93196	17
44	6 8	53 52	06911	99699	07211	92789	00301	93089	16
45	11 6 0	0 54 0	9.07018	9.99698	9.07320	10.92680	10.00302	10.92982	15
46	5 52	54 8	07124	99696	07428	92572	00304	92876	14
47	5 44	54 16	07231	99695	07536	92464	00305	92769	13
48	5 36	54 24	07337	99693	07643	92357	00307	92663	12
49	5 28	54 32	07442	99692	07751	92249	00308	92558	11
50	11 5 20	0 54 40	9.07548	9.99690	9.07858	10.92142	10.00310	10.92452	10
51	5 12	54 48	07653	99689	07964	92036	00311	92347	9
52	5 4	54 56	07758	99687	08071	91929	00313	92242	8
53	4 56	55 4	07863	99686	08177	91823	00314	92137	7
54	4 48	55 12	07968	99684	08283	91717	00316	92032	6
55	11 4 40	0 55 20	9.08072	9.99683	9.08389	10.91611	10.00317	10.91928	5
56	4 32	55 28	08176	99681	08495	91505	00319	91824	4
57	4 24	55 36	08280	99680	08600	91400	00320	91720	3
58	4 16	55 44	08383	99678	08705	91295	00322	91617	2
59	4 8	55 52	08486	99677	08810	91190	00323	91514	1
60	4 0	56 0	08589	99675	08914	91086	00325	91411	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

96 Degs. | Degs. 83.

Log. Sines, Tangents and Secants.

7 Degs. Degs. 172.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	11 4 0	0 56 0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
1	3 52	56 8	08692	99674	09019	90981	00326	91308	59
2	3 44	56 16	08795	99672	09123	90877	00328	91205	58
3	3 36	56 24	08897	99670	09227	90773	00330	91103	57
4	3 28	56 32	08999	99669	09330	90670	00331	91001	56
5	11 3 20	0 56 40	9.09101	9.99667	9.09434	10.90566	10.00333	10.90899	55
6	3 12	56 48	09202	99666	09537	90463	00334	90798	54
7	3 4	56 56	09304	99664	09640	90360	00336	90696	53
8	2 56	57 4	09405	99663	09742	90258	00337	90595	52
9	2 48	57 12	09506	99661	09845	90155	00339	90494	51
10	11 2 40	0 57 20	9.09606	9.99659	9.09947	10.90053	10.00341	10.90394	50
11	2 32	57 28	09707	99658	10049	89951	00342	90293	49
12	2 24	57 36	09807	99656	10150	89850	00344	90193	48
13	2 16	57 44	09907	99655	10252	89748	00345	90093	47
14	2 8	57 52	10006	99653	10353	89647	00347	89994	46
15	11 2 0	0 58 0	9.10106	9.99651	9.10454	10.89546	10.00349	10.89894	45
16	1 52	58 8	10205	99650	10555	89445	00350	89795	44
17	1 44	58 16	10304	99648	10656	89344	00352	89696	43
18	1 36	58 24	10402	99647	10756	89244	00353	89598	42
19	1 28	58 32	10501	99645	10856	89144	00355	89499	41
20	11 1 20	0 58 40	9.10599	9.99643	9.10956	10.89044	10.00357	10.89401	40
21	1 12	58 48	10697	99642	11056	88944	00358	89303	39
22	1 4	58 56	10795	99640	11155	88845	00360	89205	38
23	0 56	59 4	10893	99638	11254	88746	00362	89107	37
24	0 48	59 12	10990	99637	11353	88647	00363	89010	36
25	11 0 40	0 59 20	9.11087	9.99635	9.11452	10.88548	10.00365	10.88913	35
26	0 32	59 28	11184	99633	11551	88449	00367	88816	34
27	0 24	59 36	11281	99632	11649	88351	00368	88719	33
28	0 16	59 44	11377	99630	11747	88253	00370	88623	32
29	0 8	59 52	11474	99629	11845	88155	00371	88526	31
30	11 0 0	1 0 0	9.11570	9.99627	9.11943	10.88057	10.00373	10.88430	30
31	10 59 52	0 8	11666	99625	12040	87960	00375	88334	29
32	59 44	0 16	11761	99624	12138	87862	00376	88239	28
33	59 36	0 24	11857	99622	12235	87765	00378	88143	27
34	59 28	0 32	11952	99620	12332	87668	00380	88048	26
35	10 59 20	1 0 40	9.12047	9.99618	9.12428	10.87572	10.00382	10.87953	25
36	59 12	0 48	12142	99617	12525	87475	00383	87858	24
37	59 4	0 56	12236	99615	12621	87379	00385	87764	23
38	58 56	1 4	12331	99613	12717	87283	00387	87669	22
39	58 48	1 12	12425	99612	12813	87187	00388	87575	21
40	10 58 40	1 1 20	9.12519	9.99610	9.12909	10.87091	10.00390	10.87481	20
41	58 32	1 28	12612	99608	13004	86996	00392	87388	19
42	58 24	1 36	12706	99607	13099	86901	00393	87294	18
43	58 16	1 44	12799	99605	13194	86806	00395	87201	17
44	58 8	1 52	12892	99603	13289	86711	00397	87108	16
45	10 58 0	1 2 0	9.12985	9.99601	9.13384	10.86616	10.00399	10.87015	15
46	57 52	2 8	13078	99600	13478	86522	00400	86922	14
47	57 44	2 16	13171	99598	13573	86427	00402	86829	13
48	57 36	2 24	13263	99596	13667	86333	00404	86737	12
49	57 28	2 32	13355	99595	13761	86239	00405	86645	11
50	10 57 20	1 2 40	9.13447	9.99593	9.13854	10.86146	10.00407	10.86553	10
51	57 12	2 48	13539	99591	13948	86052	00409	86461	9
52	57 4	2 56	13630	99589	14041	85959	00411	86370	8
53	56 56	3 4	13722	99588	14134	85866	00412	86278	7
54	56 48	3 12	13813	99586	14227	85773	00414	86187	6
55	10 56 40	1 3 20	9.13904	9.99584	9.14320	10.85680	10.00416	10.86096	5
56	56 32	3 28	13994	99582	14412	85588	00418	86006	4
57	56 24	3 36	14085	99581	14504	85496	00419	85915	3
58	56 16	3 44	14175	99579	14597	85403	00421	85825	2
59	56 8	3 52	14266	99577	14688	85312	00423	85734	1
60	56 0	4 0	14356	99575	14780	85220	00425	85644	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

97 Degs. Degs. 82.

TABLE XXVII.

Log. Sines, Tangents and Secants.

8 Degs. Degs. 171.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 56 0	1 4 0	9.14356	9.99575	9.14780	10.85220	10.00425	10.85644	60
1	55 52	4 8	14445	99574	14872	85128	00426	85555	59
2	55 44	4 16	14535	99572	14963	85037	00428	85465	58
3	55 36	4 24	14624	99570	15054	84946	00430	85376	57
4	55 28	4 32	14714	99568	15145	84855	00432	85286	56
5	10 55 20	1 4 40	9.14803	9.99566	9.15236	10.84764	10.00434	10.85197	55
6	55 12	4 48	14891	99565	15327	84673	00435	85109	54
7	55 4	4 56	14980	99563	15417	84583	00437	85020	53
8	54 56	5 4	15069	99561	15508	84492	00439	84931	52
9	54 48	5 12	15157	99559	15598	84402	00441	84843	51
10	10 54 40	1 5 20	9.15245	9.99557	9.15688	10.84312	10.00443	10.84755	50
11	54 32	5 28	15333	99556	15777	84223	00444	84667	49
12	54 24	5 36	15421	99554	15867	84133	00446	84579	48
13	54 16	5 44	15508	99552	15956	84044	00448	84492	47
14	54 8	5 52	15596	99550	16046	83954	00450	84404	46
15	10 54 0	1 6 0	9.15683	9.99548	9.16135	10.83865	10.00452	10.84317	45
16	53 52	6 8	15770	99546	16224	83776	00454	84230	44
17	53 44	6 16	15857	99545	16312	83688	00455	84143	43
18	53 36	6 24	15944	99543	16401	83599	00457	84056	42
19	53 28	6 32	16030	99541	16489	83511	00459	83970	41
20	10 53 20	1 6 40	9.16116	9.99539	9.16577	10.83423	10.00461	10.83884	40
21	53 12	6 48	16203	99537	16665	83335	00463	83797	39
22	53 4	6 56	16289	99535	16753	83247	00465	83711	38
23	52 56	7 4	16374	99533	16841	83159	00467	83626	37
24	52 48	7 12	16460	99532	16928	83072	00468	83540	36
25	10 52 40	1 7 20	9.16545	9.99530	9.17016	10.82984	10.00470	10.83455	35
26	52 32	7 28	16631	99528	17103	82897	00472	83369	34
27	52 24	7 36	16716	99526	17190	82810	00474	83284	33
28	52 16	7 44	16801	99524	17277	82723	00476	83199	32
29	52 8	7 52	16886	99522	17363	82637	00478	83114	31
30	10 52 0	1 8 0	9.16970	9.99520	9.17450	10.82550	10.00480	10.83030	30
31	51 52	8 8	17055	99518	17536	82464	00482	82946	29
32	51 44	8 16	17139	99517	17622	82378	00483	82861	28
33	51 36	8 24	17223	99515	17708	82292	00485	82777	27
34	51 28	8 32	17307	99513	17794	82206	00487	82693	26
35	10 51 20	1 8 40	9.17391	9.99511	9.17880	10.82120	10.00489	10.82609	25
36	51 12	8 48	17474	99509	17965	82035	00491	82526	24
37	51 4	8 56	17558	99507	18051	81949	00493	82442	23
38	50 56	9 4	17641	99505	18136	81864	00495	82359	22
39	50 48	9 12	17724	99503	18221	81779	00497	82276	21
40	10 50 40	1 9 20	9.17807	9.99501	9.18306	10.81694	10.00499	10.82193	20
41	50 32	9 28	17890	99499	18391	81609	00501	82110	19
42	50 24	9 36	17973	99497	18475	81525	00503	82027	18
43	50 16	9 44	18055	99495	18560	81440	00505	81945	17
44	50 8	9 52	18137	99494	18644	81356	00506	81863	16
45	10 50 0	1 10 0	9.18220	9.99492	9.18728	10.81272	10.00508	10.81780	15
46	49 52	10 8	18302	99490	18812	81188	00510	81698	14
47	49 44	10 16	18383	99488	18896	81104	00512	81617	13
48	49 36	10 24	18465	99486	18979	81021	00514	81535	12
49	49 28	10 32	18547	99484	19063	80937	00516	81453	11
50	10 49 20	1 10 40	9.18628	9.99482	9.19146	10.80854	10.00518	10.81372	10
51	49 12	10 48	18709	99480	19229	80771	00520	81291	9
52	49 4	10 56	18790	99478	19312	80688	00522	81210	8
53	48 56	11 4	18871	99476	19395	80605	00524	81129	7
54	48 48	11 12	18952	99474	19478	80522	00526	81048	6
55	10 48 40	1 11 20	9.19033	9.99472	9.19561	10.80439	10.00528	10.80967	5
56	48 32	11 28	19113	99470	19643	80357	00530	80887	4
57	48 24	11 36	19193	99468	19725	80275	00532	80807	3
58	48 16	11 44	19273	99466	19807	80193	00534	80727	2
59	48 8	11 52	19353	99464	19889	80111	00536	80647	1
60	48 0	12 0	19433	99462	19971	80029	00538	80567	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

98 Degs. Degs. 81.

Log. Sines, Tangents and Secants.

9 Degs. Degs. 170.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 48 0	1 12 0	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	60
1	47 52	12 8	19513	99460	20053	79947	00540	80487	59
2	47 44	12 16	19592	99458	20134	79866	00542	80408	58
3	47 36	12 24	19672	99456	20216	79784	00544	80328	57
4	47 28	12 32	19751	99454	20297	79703	00546	80249	56
5	10 47 20	1 12 40	9.19830	9.99452	9.20378	10.79622	10.00548	10.80170	55
6	47 12	12 48	19909	99450	20459	79541	00550	80091	54
7	47 4	12 56	19988	99448	20540	79460	00552	80012	53
8	46 56	13 4	20067	99446	20621	79379	00554	79933	52
9	46 48	13 12	20145	99444	20701	79299	00556	79855	51
10	10 46 40	1 13 20	9.20223	9.99442	9.20782	10.79218	10.00558	10.79777	50
11	46 32	13 28	20302	99440	20862	79138	00560	79698	49
12	46 24	13 36	20380	99438	20942	79058	00562	79620	48
13	46 16	13 44	20458	99436	21022	78978	00564	79542	47
14	46 8	13 52	20535	99434	21102	78898	00566	79465	46
15	10 46 0	1 14 0	9.20613	9.99432	9.21182	10.78818	10.00568	10.79387	45
16	45 52	14 8	20691	99429	21261	78739	00571	79309	44
17	45 44	14 16	20768	99427	21341	78659	00573	79232	43
18	45 36	14 24	20845	99425	21420	78580	00575	79155	42
19	45 28	14 32	20922	99423	21499	78501	00577	79078	41
20	10 45 20	1 14 40	9.20999	9.99421	9.21578	10.78422	10.00579	10.79001	40
21	45 12	14 48	21076	99419	21657	78343	00581	78924	39
22	45 4	14 56	21153	99417	21736	78264	00583	78847	38
23	44 56	15 4	21229	99415	21814	78186	00585	78771	37
24	44 48	15 12	21306	99413	21893	78107	00587	78694	36
25	10 44 40	1 15 20	9.21382	9.99411	9.21971	10.78029	10.00589	10.78618	35
26	44 32	15 28	21458	99409	22049	77951	00591	78542	34
27	44 24	15 36	21534	99407	22127	77873	00593	78466	33
28	44 16	15 44	21610	99404	22205	77795	00596	78390	32
29	44 8	15 52	21685	99402	22283	77717	00598	78315	31
30	10 44 0	1 16 0	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
31	43 52	16 8	21836	99398	22438	77562	00602	78164	29
32	43 44	16 16	21912	99396	22516	77484	00604	78088	28
33	43 36	16 24	21987	99394	22593	77407	00606	78013	27
34	43 28	16 32	22062	99392	22670	77330	00608	77938	26
35	10 43 20	1 16 40	9.22137	9.99390	9.22747	10.77253	10.00610	10.77863	25
36	43 12	16 48	22211	99388	22824	77176	00612	77789	24
37	43 4	16 56	22286	99385	22901	77099	00615	77714	23
38	42 56	17 4	22361	99383	22977	77023	00617	77639	22
39	42 48	17 12	22435	99381	23054	76946	00619	77565	21
40	10 42 40	1 17 20	9.22509	9.99379	9.23130	10.76870	10.00621	10.77491	20
41	42 32	17 28	22583	99377	23206	76794	00623	77417	19
42	42 24	17 36	22657	99375	23283	76717	00625	77343	18
43	42 16	17 44	22731	99372	23359	76641	00628	77269	17
44	42 8	17 52	22805	99370	23435	76565	00630	77195	16
45	10 42 0	1 18 0	9.22878	9.99368	9.23510	10.76490	10.00632	10.77122	15
46	41 52	18 8	22952	99366	23586	76414	00634	77048	14
47	41 44	18 16	23025	99364	23661	76339	00636	76975	13
48	41 36	18 24	23098	99362	23737	76263	00638	76902	12
49	41 28	18 32	23171	99359	23812	76188	00641	76829	11
50	10 41 20	1 18 40	9.23244	9.99357	9.23887	10.76113	10.00643	10.76756	10
51	41 12	18 48	23317	99355	23962	76038	00645	76683	9
52	41 4	18 56	23390	99353	24037	75963	00647	76610	8
53	40 56	19 4	23462	99351	24112	75888	00649	76538	7
54	40 48	19 12	23535	99348	24186	75814	00652	76465	6
55	10 40 40	1 19 20	9.23607	9.99346	9.24261	10.75739	10.00654	10.76393	5
56	40 32	19 28	23679	99344	24335	75665	00656	76321	4
57	40 24	19 36	23752	99342	24410	75590	00658	76248	3
58	40 16	19 44	23823	99340	24484	75516	00660	76177	2
59	40 8	19 52	23895	99337	24558	75442	00663	76105	1
60	40 0	20 0	23967	99335	24632	75368	00665	76033	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

99 Degs. Degs. 80.

TABLE XXVII.

Log. Sines, Tangents and Secants.

10 Degs. Degs. 169.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 40 0	1 20 0	9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	60
1	39 52	20 8	24039	99333	24706	75294	00667	75961	59
2	39 44	20 16	24110	99331	24779	75221	00669	75890	58
3	39 36	20 24	24181	99328	24853	75147	00672	75819	57
4	39 28	20 32	24253	99326	24926	75074	00674	75747	56
5	10 39 20	1 20 40	9.24324	9.99324	9.25000	10.75000	10.00676	10.75676	55
6	39 12	20 48	24395	99322	25073	74927	00678	75605	54
7	39 4	20 56	24466	99319	25146	74854	00681	75534	53
8	38 56	21 4	24536	99317	25219	74781	00683	75464	52
9	38 48	21 12	24607	99315	25292	74708	00685	75393	51
10	10 38 40	1 21 20	9.24677	9.99313	9.25365	10.74635	10.00687	10.75323	50
11	38 32	21 28	24748	99310	25437	74563	00690	75252	49
12	38 24	21 36	24818	99308	25510	74490	00692	75182	48
13	38 16	21 44	24888	99306	25582	74418	00694	75112	47
14	38 8	21 52	24958	99304	25655	74345	00696	75042	46
15	10 38 0	1 22 0	9.25028	9.99301	9.25727	10.74273	10.00699	10.74972	45
16	37 52	22 8	25098	99299	25799	74201	00701	74902	44
17	37 44	22 16	25168	99297	25871	74129	00703	74832	43
18	37 36	22 24	25237	99294	25943	74057	00706	74763	42
19	37 28	22 32	25307	99292	26015	73985	00708	74693	41
20	10 37 20	1 22 40	9.25376	9.99290	9.26086	10.73914	10.00710	10.74624	40
21	37 12	22 48	25445	99288	26158	73842	00712	74555	39
22	37 4	22 56	25514	99285	26229	73771	00715	74486	38
23	36 56	23 4	25583	99283	26301	73699	00717	74417	37
24	36 48	23 12	25652	99281	26372	73628	00719	74348	36
25	10 36 40	1 23 20	9.25721	9.99278	9.26443	10.73557	10.00722	10.74279	35
26	36 32	23 28	25790	99276	26514	73486	00724	74210	34
27	36 24	23 36	25858	99274	26585	73415	00726	74142	33
28	36 16	23 44	25927	99271	26655	73345	00729	74073	32
29	36 8	23 52	25995	99269	26726	73274	00731	74005	31
30	10 36 0	1 24 0	9.26063	9.99267	9.26797	10.73203	10.00733	10.73937	30
31	35 52	24 8	26131	99264	26867	73133	00736	73869	29
32	35 44	24 16	26199	99262	26937	73063	00738	73801	28
33	35 36	24 24	26267	99260	27008	72992	00740	73733	27
34	35 28	24 32	26335	99257	27078	72922	00743	73665	26
35	10 35 20	1 24 40	9.26403	9.99255	9.27148	10.72852	10.00745	10.73597	25
36	35 12	24 48	26470	99252	27218	72782	00748	73530	24
37	35 4	24 56	26538	99250	27288	72712	00750	73462	23
38	34 56	25 4	26605	99248	27357	72643	00752	73395	22
39	34 48	25 12	26672	99245	27427	72573	00755	73328	21
40	10 34 40	1 25 20	9.26739	9.99243	9.27496	10.72504	10.00757	10.73261	20
41	34 32	25 28	26806	99241	27566	72434	00759	73194	19
42	34 24	25 36	26873	99238	27635	72365	00762	73127	18
43	34 16	25 44	26940	99236	27704	72296	00764	73060	17
44	34 8	25 52	27007	99233	27773	72227	00767	72993	16
45	10 34 0	1 26 0	9.27073	9.99231	9.27842	10.72158	10.00769	10.72927	15
46	33 52	26 8	27140	99229	27911	72089	00771	72860	14
47	33 44	26 16	27206	99226	27980	72020	00774	72794	13
48	33 36	26 24	27273	99224	28049	71951	00776	72727	12
49	33 28	26 32	27339	99221	28117	71883	00779	72661	11
50	10 33 20	1 26 40	9.27405	9.99219	9.28186	10.71814	10.00781	10.72595	10
51	33 12	26 48	27471	99217	28254	71746	00783	72529	9
52	33 4	26 56	27537	99214	28323	71677	00786	72463	8
53	32 56	27 4	27602	99212	28391	71609	00788	72398	7
54	32 48	27 12	27668	99209	28459	71541	00791	72332	6
55	10 32 40	1 27 20	9.27734	9.99207	9.28527	10.71473	10.00793	10.72266	5
56	32 32	27 28	27799	99204	28595	71405	00796	72201	4
57	32 24	27 36	27864	99202	28662	71338	00798	72136	3
58	32 16	27 44	27930	99200	28730	71270	00800	72070	2
59	32 8	27 52	27995	99197	28798	71202	00803	72005	1
60	32 0	28 0	28060	99195	28865	71135	00805	71940	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

100 Degs. Degs. 79.

Log. Sines, Tangents and Secants.

11 Degs. Deg. 168.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	10 32 0	1 28 0	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	60
1	31 52	28 8	28125	99192	28933	71067	00808	71875	59
2	31 44	28 16	28190	99190	29000	71000	00810	71810	58
3	31 36	28 24	28254	99187	29067	70933	00813	71746	57
4	31 28	28 32	28319	99185	29134	70866	00815	71681	56
5	10 31 20	1 28 40	9.28384	9.99182	9.29201	10.70799	10.00818	10.71616	55
6	31 12	28 48	28448	99180	29268	70732	00820	71552	54
7	31 4	28 56	28512	99177	29335	70665	00823	71488	53
8	30 56	29 4	28577	99175	29402	70598	00825	71423	52
9	30 48	29 12	28641	99172	29468	70532	00828	71359	51
10	10 30 40	1 29 20	9.28705	9.99170	9.29535	10.70465	10.00830	10.71295	50
11	30 32	29 28	28769	99167	29601	70399	00833	71231	49
12	30 24	29 36	28833	99165	29668	70332	00835	71167	48
13	30 16	29 44	28896	99162	29734	70266	00838	71104	47
14	30 8	29 52	28960	99160	29800	70200	00840	71040	46
15	10 30 0	1 30 0	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	45
16	29 52	30 8	29087	99155	29932	70068	00845	70913	44
17	29 44	30 16	29150	99152	29998	70002	00848	70850	43
18	29 36	30 24	29214	99150	30064	69936	00850	70786	42
19	29 28	30 32	29277	99147	30130	69870	00853	70723	41
20	10 29 20	1 30 40	9.29340	9.99145	9.30195	10.69805	10.00855	10.70660	40
21	29 12	30 48	29403	99142	30261	69739	00858	70597	39
22	29 4	30 56	29466	99140	30326	69674	00860	70534	38
23	28 56	31 4	29529	99137	30391	69609	00863	70471	37
24	28 48	31 12	29591	99135	30457	69543	00865	70409	36
25	10 28 40	1 31 20	9.29654	9.99132	9.30522	10.69478	10.00868	10.70346	35
26	28 32	31 28	29716	99130	30587	69413	00870	70284	34
27	28 24	31 36	29779	99127	30652	69348	00873	70221	33
28	28 16	31 44	29841	99124	30717	69283	00876	70159	32
29	28 8	31 52	29903	99122	30782	69218	00878	70097	31
30	10 28 0	1 32 0	9.29966	9.99119	9.30846	10.69154	10.00881	10.70034	30
31	27 52	32 8	30028	99117	30911	69089	00883	69972	29
32	27 44	32 16	30090	99114	30975	69025	00886	69910	28
33	27 36	32 24	30151	99112	31040	68960	00888	69849	27
34	27 28	32 32	30213	99109	31104	68896	00891	69787	26
35	10 27 20	1 32 40	9.30275	9.99106	9.31168	10.68832	10.00894	10.69725	25
36	27 12	32 48	30336	99104	31233	68767	00896	69664	24
37	27 4	32 56	30398	99101	31297	68703	00899	69602	23
38	26 56	33 4	30459	99099	31361	68639	00901	69541	22
39	26 48	33 12	30521	99096	31425	68575	00904	69479	21
40	10 26 40	1 33 20	9.30582	9.99093	9.31489	10.68511	10.00907	10.69418	20
41	26 32	33 28	30643	99091	31552	68448	00909	69357	19
42	26 24	33 36	30704	99088	31616	68384	00912	69296	18
43	26 16	33 44	30765	99086	31679	68321	00914	69235	17
44	26 8	33 52	30826	99083	31743	68257	00917	69174	16
45	10 26 0	1 34 0	9.30887	9.99080	9.31806	10.68194	10.00920	10.69113	15
46	25 52	34 8	30947	99078	31870	68130	00922	69053	14
47	25 44	34 16	31008	99075	31933	68067	00925	68992	13
48	25 36	34 24	31068	99072	31996	68004	00928	68932	12
49	25 28	34 32	31129	99070	32059	67941	00930	68871	11
50	10 25 20	1 34 40	9.31189	9.99067	9.32122	10.67878	10.00933	10.68811	10
51	25 12	34 48	31250	99064	32185	67815	00936	68750	9
52	25 4	34 56	31310	99062	32248	67752	00938	68690	8
53	24 56	35 4	31370	99059	32311	67689	00941	68630	7
54	24 48	35 12	31430	99056	32373	67627	00944	68570	6
55	10 24 40	1 35 20	9.31490	9.99054	9.32436	10.67564	10.00946	10.68510	5
56	24 32	35 28	31549	99051	32498	67502	00949	68451	4
57	24 24	35 36	31609	99048	32561	67439	00952	68391	3
58	24 16	35 44	31669	99046	32623	67377	00954	68331	2
59	24 8	35 52	31728	99043	32685	67315	00957	68272	1
60	24 0	36 0	31788	99040	32747	67253	00960	68212	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

101 Degs. Degs. 78.

TABLE XXVII.
Log. Sines, Tangents and Secants.

12 Degs. | Degs. 167.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 24 0	1 36 0	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	60
1	23 52	36 8	31847	99038	32810	67190	00962	68153	59
2	23 44	36 16	31907	99035	32872	67128	00965	68093	58
3	23 36	36 24	31966	99032	32933	67067	00968	68034	57
4	23 28	36 32	32025	99030	32995	67005	00970	67975	56
5	10 23 20	1 36 40	9.32084	9.99027	9.33057	10.66943	10.00973	10.67916	55
6	23 12	36 48	32143	99024	33119	66881	00976	67857	54
7	23 4	36 56	32202	99022	33180	66820	00978	67798	53
8	22 56	37 4	32261	99019	33242	66758	00981	67739	52
9	22 48	37 12	32319	99016	33303	66697	00984	67681	51
10	10 22 40	1 37 20	9.32378	9.99013	9.33365	10.66635	10.00987	10.67622	50
11	22 32	37 28	32437	99011	33426	66574	00989	67563	49
12	22 24	37 36	32495	99008	33487	66513	00992	67505	48
13	22 16	37 44	32553	99005	33548	66452	00995	67447	47
14	22 8	37 52	32612	99002	33609	66391	00998	67388	46
15	10 22 0	1 38 0	9.32670	9.99000	9.33670	10.66330	10.01000	10.67330	45
16	21 52	38 8	32728	98997	33731	66269	01003	67272	44
17	21 44	38 16	32786	98994	33792	66208	01006	67214	43
18	21 36	38 24	32844	98991	33853	66147	01009	67156	42
19	21 28	38 32	32902	98989	33913	66087	01011	67098	41
20	10 21 20	1 38 40	9.32960	9.98986	9.33974	10.66026	10.01014	10.67040	40
21	21 12	38 48	33018	98983	34034	65966	01017	66982	39
22	21 4	38 56	33075	98980	34095	65905	01020	66925	38
23	20 56	39 4	33133	98978	34155	65845	01022	66867	37
24	20 48	39 12	33190	98975	34215	65785	01025	66810	36
25	10 20 40	1 39 20	9.33248	9.98972	9.34276	10.65724	10.01028	10.66752	35
26	20 32	39 28	33305	98969	34336	65664	01031	66695	34
27	20 24	39 36	33362	98967	34396	65604	01033	66638	33
28	20 16	39 44	33420	98964	34456	65544	01036	66580	32
29	20 8	39 52	33477	98961	34516	65484	01039	66523	31
30	10 20 0	1 40 0	9.33534	9.98958	9.34576	10.65424	10.01042	10.66466	30
31	19 52	40 8	33591	98955	34635	65365	01045	66409	29
32	19 44	40 16	33647	98953	34695	65305	01047	66353	28
33	19 36	40 24	33704	98950	34755	65245	01050	66296	27
34	19 28	40 32	33761	98947	34814	65186	01053	66239	26
35	10 19 20	1 40 40	9.33818	9.98944	9.34874	10.65126	10.01056	10.66182	25
36	19 12	40 48	33874	98941	34933	65067	01059	66126	24
37	19 4	40 56	33931	98938	34992	65008	01062	66069	23
38	18 56	41 4	33987	98936	35051	64949	01064	66013	22
39	18 48	41 12	34043	98933	35111	64889	01067	65957	21
40	10 18 40	1 41 20	9.34100	9.98930	9.35170	10.64830	10.01070	10.65900	20
41	18 32	41 28	34156	98927	35229	64771	01073	65844	19
42	18 24	41 36	34212	98924	35288	64712	01076	65788	18
43	18 16	41 44	34268	98921	35347	64653	01079	65732	17
44	18 8	41 52	34324	98919	35405	64595	01081	65676	16
45	10 18 0	1 42 0	9.34380	9.98916	9.35464	10.64536	10.01084	10.65620	15
46	17 52	42 8	34436	98913	35523	64477	01087	65564	14
47	17 44	42 16	34491	98910	35581	64419	01090	65509	13
48	17 36	42 24	34547	98907	35640	64360	01093	65453	12
49	17 28	42 32	34602	98904	35698	64302	01096	65398	11
50	10 17 20	1 42 40	9.34658	9.98901	9.35757	10.64243	10.01099	10.65342	10
51	17 12	42 48	34713	98898	35815	64185	01102	65287	9
52	17 4	42 56	34769	98896	35873	64127	01104	65231	8
53	16 56	43 4	34824	98893	35931	64069	01107	65176	7
54	16 48	43 12	34879	98890	35989	64011	01110	65121	6
55	10 16 40	1 43 20	9.34934	9.98887	9.36047	10.63953	10.01113	10.65066	5
56	16 32	43 28	34989	98884	36105	63895	01116	65011	4
57	16 24	43 36	35044	98881	36163	63837	01119	64956	3
58	16 16	43 44	35099	98878	36221	63779	01122	64901	2
59	16 8	43 52	35154	98875	36279	63721	01125	64846	1
60	16 0	44 0	35209	98872	36336	63664	01128	64791	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

102 Degs. | Degs. 77

TABLE XXVII.

Log. Sines, Tangents and Secants.

13 Degs. Degs. 166.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 16 0	1 44 0	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	60
1	15 52	44 8	35263	98869	36394	63606	01131	64737	59
2	15 44	44 16	35318	98867	36452	63548	01133	64682	58
3	15 36	44 24	35373	98864	36509	63491	01136	64627	57
4	15 28	44 32	35427	98861	36566	63434	01139	64573	56
5	10 15 20	1 44 40	9.35481	9.98858	9.36624	10.63376	10.01142	10.64519	55
6	15 12	44 48	35536	98855	36681	63319	01145	64464	54
7	15 4	44 56	35590	98852	36738	63262	01148	64410	53
8	14 56	45 4	35644	98849	36795	63205	01151	64356	52
9	14 48	45 12	35698	98846	36852	63148	01154	64302	51
10	10 14 40	1 45 20	9.35752	9.98843	9.36909	10.63091	10.01157	10.64248	50
11	14 32	45 28	35806	98840	36966	63034	01160	64194	49
12	14 24	45 36	35860	98837	37023	62977	01163	64140	48
13	14 16	45 44	35914	98834	37080	62920	01166	64086	47
14	14 8	45 52	35968	98831	37137	62863	01169	64032	46
15	10 14 0	1 46 0	9.36022	9.98828	9.37193	10.62807	10.01172	10.63978	45
16	13 52	46 8	36075	98825	37250	62750	01175	63925	44
17	13 44	46 16	36129	98822	37306	62694	01178	63871	43
18	13 36	46 24	36182	98819	37363	62637	01181	63818	42
19	13 28	46 32	36236	98816	37419	62581	01184	63764	41
20	10 13 20	1 46 40	9.36289	9.98813	9.37476	10.62524	10.01187	10.63711	40
21	13 12	46 48	36342	98810	37532	62468	01190	63658	39
22	13 4	46 56	36395	98807	37588	62412	01193	63605	38
23	12 56	47 4	36449	98804	37644	62356	01196	63551	37
24	12 48	47 12	36502	98801	37700	62300	01199	63498	36
25	10 12 40	1 47 20	9.36555	9.98798	9.37756	10.62244	10.01202	10.63445	35
26	12 32	47 28	36608	98795	37812	62188	01205	63392	34
27	12 24	47 36	36660	98792	37868	62132	01208	63340	33
28	12 16	47 44	36713	98789	37924	62076	01211	63287	32
29	12 8	47 52	36766	98786	37980	62020	01214	63234	31
30	10 12 0	1 48 0	9.36819	9.98783	9.38035	10.61965	10.01217	10.63181	30
31	11 52	48 8	36871	98780	38091	61909	01220	63129	29
32	11 44	48 16	36924	98777	38147	61853	01223	63076	28
33	11 36	48 24	36976	98774	38202	61798	01226	63024	27
34	11 28	48 32	37028	98771	38257	61743	01229	62972	26
35	10 11 20	1 48 40	9.37081	9.98768	9.38313	10.61687	10.01232	10.62919	25
36	11 12	48 48	37133	98765	38368	61632	01235	62867	24
37	11 4	48 56	37185	98762	38423	61577	01238	62815	23
38	10 56	49 4	37237	98759	38479	61521	01241	62763	22
39	10 48	49 12	37289	98756	38534	61466	01244	62711	21
40	10 10 40	1 49 20	9.37341	9.98753	9.38589	10.61411	10.01247	10.62659	20
41	10 32	49 28	37393	98750	38644	61356	01250	62607	19
42	10 24	49 36	37445	98746	38699	61301	01254	62555	18
43	10 16	49 44	37497	98743	38754	61246	01257	62503	17
44	10 8	49 52	37549	98740	38808	61192	01260	62451	16
45	10 10 0	1 50 0	9.37600	9.98737	9.38863	10.61137	10.01263	10.62400	15
46	9 52	50 8	37652	98734	38918	61082	01266	62348	14
47	9 44	50 16	37703	98731	38972	61028	01269	62297	13
48	9 36	50 24	37755	98728	39027	60973	01272	62245	12
49	9 28	50 32	37806	98725	39082	60918	01275	62194	11
50	10 9 20	1 50 40	9.37858	9.98722	9.39136	10.60864	10.01278	10.62142	10
51	9 12	50 48	37909	98719	39190	60810	01281	62091	9
52	9 4	50 56	37960	98715	39245	60755	01285	62040	8
53	8 56	51 4	38011	98712	39299	60701	01288	61989	7
54	8 48	51 12	38062	98709	39353	60647	01291	61938	6
55	10 8 40	1 51 20	9.38113	9.98706	9.39407	10.60593	10.01294	10.61887	5
56	8 32	51 28	38164	98703	39461	60539	01297	61836	4
57	8 24	51 36	38215	98700	39515	60485	01300	61785	3
58	8 16	51 44	38266	98697	39569	60431	01303	61734	2
59	8 8	51 52	38317	98694	39623	60377	01306	61683	1
60	8 0	52 0	38368	98690	39677	60323	01310	61632	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

103 Degs. Degs. 76.

TABLE XXVII.

Log. Sines, Tangents and Secants.

14 Degs. Deg. 165.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10 8 0	1 52 0	9.38368	9.98690	9.39677	10.60323	10.01310	10.61632	60
1	7 52	52 8	38418	98687	39731	60269	01313	61582	59
2	7 44	52 16	38469	98684	39785	60215	01316	61531	58
3	7 36	52 24	38519	98681	39838	60162	01319	61481	57
4	7 28	52 32	38570	98678	39892	60108	01322	61430	56
5	10 7 20	1 52 40	9.38620	9.98675	9.39945	10.60055	10.01325	10.61380	55
6	7 12	52 48	38670	98671	39999	60001	01329	61330	54
7	7 4	52 56	38721	98668	40052	59948	01332	61279	53
8	6 56	53 4	38771	98665	40106	59894	01335	61229	52
9	6 48	53 12	38821	98662	40159	59841	01338	61179	51
10	10 6 40	1 53 20	9.38871	9.98659	9.40212	10.59788	10.01341	10.61129	50
11	6 32	53 28	38921	98656	40266	59734	01344	61079	49
12	6 24	53 36	38971	98652	40319	59681	01348	61029	48
13	6 16	53 44	39021	98649	40372	59628	01351	60979	47
14	6 8	53 52	39071	98646	40425	59575	01354	60929	46
15	10 6 0	1 54 0	9.39121	9.98643	9.40478	10.59522	10.01357	10.60879	45
16	5 52	54 8	39170	98640	40531	59469	01360	60830	44
17	5 44	54 16	39220	98636	40584	59416	01364	60780	43
18	5 36	54 24	39270	98633	40636	59364	01367	60730	42
19	5 28	54 32	39319	98630	40689	59311	01370	60681	41
20	10 5 20	1 54 40	9.39369	9.98627	9.40742	10.59258	10.01373	10.60631	40
21	5 12	54 48	39418	98623	40795	59205	01377	60582	39
22	5 4	54 56	39467	98620	40847	59153	01380	60533	38
23	4 56	55 4	39517	98617	40900	59100	01383	60483	37
24	4 48	55 12	39566	98614	40952	59048	01386	60434	36
25	10 4 40	1 55 20	9.39615	9.98610	9.41005	10.58995	10.01390	10.60385	35
26	4 32	55 28	39664	98607	41057	58943	01393	60336	34
27	4 24	55 36	39713	98604	41109	58891	01396	60287	33
28	4 16	55 44	39762	98601	41161	58839	01399	60238	32
29	4 8	55 52	39811	98597	41214	58786	01403	60189	31
30	10 4 0	1 56 0	9.39860	9.98594	9.41266	10.58734	10.01406	10.60140	30
31	3 52	56 8	39909	98591	41318	58682	01409	60091	29
32	3 44	56 16	39958	98588	41370	58630	01412	60042	28
33	3 36	56 24	40006	98584	41422	58578	01416	59994	27
34	3 28	56 32	40055	98581	41474	58526	01419	59945	26
35	10 3 20	1 56 40	9.40103	9.98578	9.41526	10.58474	10.01422	10.59897	25
36	3 12	56 48	40152	98574	41578	58422	01426	59848	24
37	3 4	56 56	40200	98571	41629	58371	01429	59800	23
38	2 56	57 4	40249	98568	41681	58319	01432	59751	22
39	2 48	57 12	40297	98565	41733	58267	01435	59703	21
40	10 2 40	1 57 20	9.40346	9.98561	9.41784	10.58216	10.01439	10.59654	20
41	2 32	57 28	40394	98558	41836	58164	01442	59606	19
42	2 24	57 36	40442	98555	41887	58113	01445	59558	18
43	2 16	57 44	40490	98551	41939	58061	01449	59510	17
44	2 8	57 52	40538	98548	41990	58010	01452	59462	16
45	10 2 0	1 58 0	9.40586	9.98545	9.42041	10.57959	10.01455	10.59414	15
46	1 52	58 8	40634	98541	42093	57907	01459	59366	14
47	1 44	58 16	40682	98538	42144	57856	01462	59318	13
48	1 36	58 24	40730	98535	42195	57805	01465	59270	12
49	1 28	58 32	40778	98531	42246	57754	01469	59222	11
50	10 1 20	1 58 40	9.40825	9.98528	9.42297	10.57703	10.01472	10.59175	10
51	1 12	58 48	40873	98525	42348	57652	01475	59127	9
52	1 4	58 56	40921	98521	42399	57601	01479	59079	8
53	0 56	59 4	40968	98518	42450	57550	01482	59032	7
54	0 48	59 12	41016	98515	42501	57499	01485	58984	6
55	10 0 40	1 59 20	9.41063	9.98511	9.42552	10.57448	10.01489	10.58937	5
56	0 32	59 28	41111	98508	42603	57397	01492	58889	4
57	0 24	59 36	41158	98505	42653	57347	01495	58842	3
58	0 16	59 44	41205	98501	42704	57296	01499	58795	2
59	0 8	59 52	41252	98498	42755	57245	01502	58748	1
60	0 0	2 0 0	41300	98494	42805	57195	01506	58700	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

104 Degs. Degs. 75.

Log. Sines, Tangents and Secants.

15 Degs. Degs. 164.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	10. 0 0	2 0 0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
1	9.59 52	0 8	41347	98491	42856	57144	01509	58653	59
2	59 44	0 16	41394	98488	42906	57094	01512	58606	58
3	59 36	0 24	41441	98484	42957	57043	01516	58559	57
4	59 28	0 32	41488	98481	43007	56993	01519	58512	56
5	9.59 20	2 0 40	9.41535	9.98477	9.43057	10.56943	10.01523	10.58465	55
6	59 12	0 48	41582	98474	43108	56892	01526	58418	54
7	59 4	0 56	41628	98471	43158	56842	01529	58372	53
8	58 56	1 4	41675	98467	43208	56792	01533	58325	52
9	58 48	1 12	41722	98464	43258	56742	01536	58278	51
10	9.58 40	2 1 20	9.41768	9.98460	9.43308	10.56692	10.01540	10.58232	50
11	58 32	1 28	41815	98457	43358	56642	01543	58185	49
12	58 24	1 36	41861	98453	43408	56592	01547	58139	48
13	58 16	1 44	41908	98450	43458	56542	01550	58092	47
14	58 8	1 52	41954	98447	43508	56492	01553	58046	46
15	9.58 0	2 2 0	9.42001	9.98443	9.43558	10.56442	10.01557	10.57999	45
16	57 52	2 8	42047	98440	43607	56393	01560	57953	44
17	57 44	2 16	42093	98436	43657	56343	01564	57907	43
18	57 36	2 24	42140	98433	43707	56293	01567	57860	42
19	57 28	2 32	42186	98429	43756	56244	01571	57814	41
20	9.57 20	2 2 40	9.42232	9.98426	9.43806	10.56194	10.01574	10.57768	40
21	57 12	2 48	42278	98422	43855	56145	01578	57722	39
22	57 4	2 56	42324	98419	43905	56095	01581	57676	38
23	56 56	3 4	42370	98415	43954	56046	01585	57630	37
24	56 48	3 12	42416	98412	44004	55996	01588	57584	36
25	9.56 40	2 3 20	9.42461	9.98409	9.44053	10.55947	10.01591	10.57539	35
26	56 32	3 28	42507	98405	44102	55898	01595	57493	34
27	56 24	3 36	42553	98402	44151	55849	01598	57447	33
28	56 16	3 44	42599	98398	44201	55799	01602	57401	32
29	56 8	3 52	42644	98395	44250	55750	01605	57356	31
30	9.56 0	2 4 0	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
31	55 52	4 8	42735	98388	44348	55652	01612	57265	29
32	55 44	4 16	42781	98384	44397	55603	01616	57219	28
33	55 36	4 24	42826	98381	44446	55554	01619	57174	27
34	55 28	4 32	42872	98377	44495	55505	01623	57123	26
35	9.55 20	2 4 40	9.42917	9.98373	9.44544	10.55456	10.01627	10.57083	25
36	55 12	4 48	42962	98370	44592	55408	01630	57038	24
37	55 4	4 56	43008	98366	44641	55359	01634	56992	23
38	54 56	5 4	43053	98363	44690	55310	01637	56947	22
39	54 48	5 12	43098	98359	44738	55262	01641	56902	21
40	9.54 40	2 5 20	9.43143	9.98356	9.44787	10.55213	10.01644	10.56857	20
41	54 32	5 28	43188	98352	44836	55164	01648	56812	19
42	54 24	5 36	43233	98349	44884	55116	01651	56767	18
43	54 16	5 44	43278	98345	44933	55067	01655	56722	17
44	54 8	5 52	43323	98342	44981	55019	01658	56677	16
45	9.54 0	2 6 0	9.43367	9.98338	9.45029	10.54971	10.01662	10.56633	15
46	53 52	6 8	43412	98334	45078	54922	01666	56588	14
47	53 44	6 16	43457	98331	45126	54874	01669	56543	13
48	53 36	6 24	43502	98327	45174	54826	01673	56498	12
49	53 28	6 32	43546	98324	45222	54778	01676	56454	11
50	9.53 20	2 6 40	9.43591	9.98320	9.45271	10.54729	10.01680	10.56409	10
51	53 12	6 48	43635	98317	45319	54681	01683	56365	9
52	53 4	6 56	43680	98313	45367	54633	01687	56320	8
53	52 56	7 4	43724	98309	45415	54585	01691	56276	7
54	52 48	7 12	43769	98306	45463	54537	01694	56231	6
55	9.52 40	2 7 20	9.43813	9.98302	9.45511	10.54489	10 01698	10.56187	5
56	52 32	7 28	43857	98299	45559	54441	01701	56143	4
57	52 24	7 36	43901	98295	45606	54394	01705	56099	3
58	52 16	7 44	43946	98291	45654	54346	01709	56054	2
59	52 8	7 52	43990	98288	45702	54298	01712	56010	1
60	52 0	8 0	44034	98284	45750	54250	01716	55966	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

105 Degs. Degs. 74.

TABLE XXVII.

Logs. Sines, Tangents and Secants.

16 Degs. Degs. 163.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 52 0	2 8 0	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	60
1	51 52	8 8	44078	98281	45797	54203	01719	55922	59
2	51 44	8 16	44122	98277	45845	54155	01723	55878	58
3	51 36	8 24	44166	98273	45892	54108	01727	55834	57
4	51 28	8 32	44210	98270	45940	54060	01730	55790	56
5	9 51 20	2 8 40	9.44253	9.98266	9.459[illegible]7	10.54013	10.01734	10.55747	55
6	51 12	8 48	44297	98262	46035	53965	01738	55703	54
7	51 4	8 56	44341	98259	46082	53918	01741	55659	53
8	50 56	9 4	44385	98255	46130	53870	01745	55615	52
9	50 48	9 12	44428	98251	46177	53823	01749	55572	51
10	9 50 40	2 9 20	9.44472	9.98248	9.46224	10.53776	10.01752	10.55528	50
11	50 32	9 28	44516	98244	46271	53729	01756	55484	49
12	50 24	9 36	44559	98240	46319	53681	01760	55441	48
13	50 16	9 44	44602	98237	46366	53634	01763	55398	47
14	50 8	9 52	44646	98233	46413	53587	01767	55354	46
15	9 50 0	2 10 0	9.44689	9.98229	9.46460	10.53540	10.01771	10.55311	45
16	49 52	10 8	44733	98226	46507	53493	01774	55267	44
17	49 44	10 16	44776	98222	46554	53446	01778	55224	43
18	49 36	10 24	44819	98218	46601	53399	01782	55181	42
19	49 28	10 32	44862	98215	46648	53352	01785	55138	41
20	9 49 20	2 10 40	9.44905	9.98211	9.46694	10.53306	10.01789	10.55095	40
21	49 12	10 48	44948	98207	46741	53259	01793	55052	39
22	49 4	10 56	44992	98204	46788	53212	01796	55008	38
23	48 56	11 4	45035	98200	46835	53165	01800	54965	37
24	48 48	11 12	45077	98196	46881	53119	01804	54923	36
25	9 48 40	2 11 20	9.45120	9.98192	9.46928	10.53072	10.01808	10.54880	35
26	48 32	11 28	45163	98189	46975	53025	01811	54837	34
27	48 24	11 36	45206	98185	47021	52979	01815	54794	33
28	48 16	11 44	45249	98181	47068	52932	01819	54751	32
29	48 8	11 52	45292	98177	47114	52886	01823	54708	31
30	9 48 0	2 12 0	9.45334	9.98174	9.47160	10.52840	10.01826	10.54666	30
31	47 52	12 8	45377	98170	47207	52793	01830	54623	29
32	47 44	12 16	45419	98166	47253	52747	01834	54581	28
33	47 36	12 24	45462	98162	47299	52701	01838	54538	27
34	47 28	12 32	45504	98159	47346	52654	01841	54496	26
35	9 47 20	2 12 40	9.45547	9.98155	9.47392	10.52608	10.01845	10.54453	25
36	47 12	12 48	45589	98151	47438	52562	01849	54411	24
37	47 4	12 56	45632	98147	47484	52516	01853	54368	23
38	46 56	13 4	45674	98144	47530	52470	01856	54326	22
39	46 48	13 12	45716	98140	47576	52424	01860	54284	21
40	9 46 40	2 13 20	9.45758	9.98136	9.47622	10.52378	10.01864	10.54242	20
41	46 32	13 28	45801	98132	47668	52332	01868	54199	19
42	46 24	13 36	45843	98129	47714	52286	01871	54157	18
43	46 16	13 44	45885	98125	47760	52240	01875	54115	17
44	46 8	13 52	45927	98121	47806	52194	01879	54073	16
45	9 46 0	2 14 0	9.45969	9.98117	9.47852	10.52148	10.01883	10.54031	15
46	45 52	14 8	46011	98113	47897	52103	01887	53989	14
47	45 44	14 16	46053	98110	47943	52057	01890	53947	13
48	45 36	14 24	46095	98106	47989	52011	01894	53905	12
49	45 28	14 32	46136	98102	48035	51965	01898	53864	11
50	9 45 20	2 14 40	9.46178	9.98098	9.48080	10.51920	10.01902	10.53822	10
51	45 12	14 48	46220	98094	48126	51874	01906	53780	9
52	45 4	14 56	46262	98090	48171	51829	01910	53738	8
53	44 56	15 4	46303	98087	48217	51783	01913	53697	7
54	44 48	15 12	46345	98083	48262	51738	01917	53655	6
55	9 44 40	2 15 20	9.46386	9.98079	9.48307	10.51693	10.01921	10.53614	5
56	44 32	15 28	46428	98075	48353	51647	01925	53572	4
57	44 24	15 36	46469	98071	48398	51602	01929	53531	3
58	44 16	15 44	46511	98067	48443	51557	01933	53489	2
59	44 8	15 52	46552	98063	48489	51511	01937	53448	1
60	44 0	16 0	46594	98060	48534	51466	01940	53406	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

106 Degs. Degs. 73.

Log. Sines, Tangents and Secants.

17 Degs. Degs. 162.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent	Co-tang	Secant.	Co-secant	M
0	9 44 0	2 16 0	9.46594	9.98060	9.48534	10.51466	10.01940	10.53406	60
1	43 52	16 8	46635	98056	48579	51421	01944	53365	59
2	43 44	16 16	46676	98052	48624	51376	01948	53324	58
3	43 36	16 24	46717	98048	48669	51331	01952	53283	57
4	43 28	16 32	46758	98044	48714	51286	01956	53242	56
5	9 43 20	2 16 40	9.46800	9.98040	9.48759	10.51241	10.01960	10.53200	55
6	43 12	16 48	46841	98036	48804	51196	01964	53159	54
7	43 4	16 56	46882	98032	48849	51151	01968	53118	53
8	42 56	17 4	46923	98029	48894	51106	01971	53077	52
9	42 48	17 12	46964	98025	48939	51061	01975	53036	51
10	9 42 40	2 17 20	9.47005	9.98021	9.48984	10.51016	10.01979	10.52995	50
11	42 32	17 28	47045	98017	49029	50971	01983	52955	49
12	42 24	17 36	47086	98013	49073	50927	01987	52914	48
13	42 16	17 44	47127	98009	49118	50882	01991	52873	47
14	42 8	17 52	47168	98005	49163	50837	01995	52832	46
15	9 42 0	2 18 0	9.47209	9.98001	9.49207	10.50793	10.01999	10.52791	45
16	41 52	18 8	47249	97997	49252	50748	02003	52751	44
17	41 44	18 16	47290	97993	49296	50704	02007	52710	43
18	41 36	18 24	47330	97989	49341	50659	02011	52670	42
19	41 28	18 32	47371	97986	49385	50615	02014	52629	41
20	9 41 20	2 18 40	9.47411	9.97982	9.49430	10.50570	10.02018	10.52589	40
21	41 12	18 48	47452	97978	49474	50526	02022	52548	39
22	41 4	18 56	47492	97974	49519	50481	02026	52508	38
23	40 56	19 4	47533	97970	49563	50437	02030	52467	37
24	40 48	19 12	47573	97966	49607	50393	02034	52427	36
25	9 40 40	2 19 20	9.47613	9.97962	9.49652	10.50348	10.02038	10.52387	35
26	40 32	19 28	47654	97958	49696	50304	02042	52346	34
27	40 24	19 36	47694	97954	49740	50260	02046	52306	33
28	40 16	19 44	47734	97950	49784	50216	02050	52266	32
29	40 8	19 52	47774	97946	49828	50172	02054	52226	31
30	9 40 0	2 20 0	9.47814	9.97942	9.49872	10.50128	10.02058	10.52186	30
31	39 52	20 8	47854	97938	49916	50084	02062	52146	29
32	39 44	20 16	47894	97934	49960	50040	02066	52106	28
33	39 36	20 24	47934	97930	50004	49996	02070	52066	27
34	39 28	20 32	47974	97926	50048	49952	02074	52026	26
35	9 39 20	2 20 40	9.48014	9.97922	9.50092	10.49908	10.02078	10.51986	25
36	39 12	20 48	48054	97918	50136	49864	02082	51946	24
37	39 4	20 56	48094	97914	50180	49820	02086	51906	23
38	38 56	21 4	48133	97910	50223	49777	02090	51867	22
39	38 48	21 12	48173	97906	50267	49733	02094	51827	21
40	9 38 40	2 21 20	9.48213	9.97902	9.50311	10.49689	10.02098	10.51787	20
41	38 32	21 28	48252	97898	50355	49645	02102	51748	19
42	38 24	21 36	48292	97894	50398	49602	02106	51708	18
43	38 16	21 44	48332	97890	50442	49558	02110	51668	17
44	38 8	21 52	48371	97886	50485	49515	02114	51629	16
45	9 38 0	2 22 0	9.48411	9.97882	9.50529	10.49471	10.02118	10.51589	15
46	37 52	22 8	48450	97878	50572	49428	02122	51550	14
47	37 44	22 16	48490	97874	50616	49384	02126	51510	13
48	37 36	22 24	48529	97870	50659	49341	02130	51471	12
49	37 28	22 32	48568	97866	50703	49297	02134	51432	11
50	9 37 20	2 22 40	9.48607	9.97861	9.50746	10.49254	10.02139	10.51393	10
51	37 12	22 48	48647	97857	50789	49211	02143	51353	9
52	37 4	22 56	48686	97853	50833	49167	02147	51314	8
53	36 56	23 4	48725	97849	50876	49124	02151	51275	7
54	36 48	23 12	48764	97845	50919	49081	02155	51236	6
55	9 36 40	2 23 20	9.48803	9.97841	9.50962	10.49038	10.02159	10.51197	5
56	36 32	23 28	48842	97837	51005	48995	02163	51158	4
57	36 24	23 36	48881	97833	51048	48952	02167	51119	3
58	36 16	23 44	48920	97829	51092	48908	02171	51080	2
59	36 8	23 52	48959	97825	51135	48865	02175	51041	1
60	36 0	24 0	48998	97821	51178	48822	02179	51002	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Cotang.	Tangent.	Co-secant	Secant.	M

107 Degs. Degs. 72.

TABLE XXVII.

Log. Sines, Tangents and Secants.

18 Degs. Degs. 161.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 36 0	2 24 0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51002	60
1	35 52	24 8	49037	97817	51221	48779	02183	50963	59
2	35 44	24 16	49076	97812	51264	48736	02188	50924	58
3	35 36	24 24	49115	97808	51306	48694	02192	50885	57
4	35 28	24 32	49153	97804	51349	48651	02196	50847	56
5	9 35 20	2 24 40	9.49192	9.97800	9.51392	10.48608	10.02200	10.50808	55
6	35 12	24 48	49231	97796	51435	48565	02204	50769	54
7	35 4	24 56	49269	97792	51478	48522	02208	50731	53
8	34 56	25 4	49308	97788	51520	48480	02212	50692	52
9	34 48	25 12	49347	97784	51563	48437	02216	50653	51
10	9 34 40	2 25 20	9.49385	9.97779	9.51606	10.48394	10.02221	10.50615	50
11	34 32	25 28	49424	97775	51648	48352	02225	50576	49
12	34 24	25 36	49462	97771	51691	48309	02229	50538	48
13	34 16	25 44	49500	97767	51734	48266	02233	50500	47
14	34 8	25 52	49539	97763	51776	48224	02237	50461	46
15	9 34 0	2 26 0	9.49577	9.97759	9.51819	10.48181	10.02241	10.50423	45
16	33 52	26 8	49615	97754	51861	48139	02246	50385	44
17	33 44	26 16	49654	97750	51903	48097	02250	50346	43
18	33 36	26 24	49692	97746	51946	48054	02254	50308	42
19	33 28	26 32	49730	97742	51988	48012	02258	50270	41
20	9 33 20	2 26 40	9.49768	9.97738	9.52031	10.47969	10.02262	10.50232	40
21	33 12	26 48	49806	97734	52073	47927	02266	50194	39
22	33 4	26 56	49844	97729	52115	47885	02271	50156	38
23	32 56	27 4	49882	97725	52157	47843	02275	50118	37
24	32 48	27 12	49920	97721	52200	47800	02279	50080	36
25	9 32 40	2 27 20	9.49958	9.97717	9.52242	10.47758	10.02283	10.50042	35
26	32 32	27 28	49996	97713	52284	47716	02287	50004	34
27	32 24	27 36	50034	97708	52326	47674	02292	49966	33
28	32 16	27 44	50072	97704	52368	47632	02296	49928	32
29	32 8	27 52	50110	97700	52410	47590	02300	49890	31
30	9 32 0	2 28 0	9.50148	9.97696	9.52452	10.47548	10.02304	10.49852	30
31	31 52	28 8	50185	97691	52494	47506	02309	49815	29
32	31 44	28 16	50223	97687	52536	47464	02313	49777	28
33	31 36	28 24	50261	97683	52578	47422	02317	49739	27
34	31 28	28 32	50298	97679	52620	47380	02321	49702	26
35	9 31 20	2 28 40	9.50336	9.97674	9.52661	10.47339	10.02326	10.49664	25
36	31 12	28 48	50374	97670	52703	47297	02330	49626	24
37	31 4	28 56	50411	97666	52745	47255	02334	49589	23
38	30 56	29 4	50449	97662	52787	47213	02338	49551	22
39	30 48	29 12	50486	97657	52829	47171	02343	49514	21
40	9 30 40	2 29 20	9.50523	9.97653	9.52870	10.47130	10.02347	10.49477	20
41	30 32	29 28	50561	97649	52912	47088	02351	49439	19
42	30 24	29 36	50598	97645	52953	47047	02355	49402	18
43	30 16	29 44	50635	97640	52995	47005	02360	49365	17
44	30 8	29 52	50673	97636	53037	46963	02364	49327	16
45	9 30 0	2 30 0	9.50710	9.97632	9.53078	10.46922	10.02368	10.49290	15
46	29 52	30 8	50747	97628	53120	46880	02372	49253	14
47	29 44	30 16	50784	97623	53161	46839	02377	49216	13
48	29 36	30 24	50821	97619	53202	46798	02381	49179	12
49	29 28	30 32	50858	97615	53244	46756	02385	49142	11
50	9 29 20	2 30 40	9.50896	9.97610	9.53285	10.46715	10.02390	10.49104	10
51	29 12	30 48	50933	97606	53327	46673	02394	49067	9
52	29 4	30 56	50970	97602	53368	46632	02398	49030	8
53	28 56	31 4	51007	97597	53409	46591	02403	48993	7
54	28 48	31 12	51043	97593	53450	46550	02407	48957	6
55	9 28 40	2 31 20	9.51080	9.97589	9.53492	10.46508	10.02411	10.48920	5
56	28 32	31 28	51117	97584	53533	46467	02416	48883	4
57	28 24	31 36	51154	97580	53574	46426	02420	48846	3
58	28 16	31 44	51191	97576	53615	46385	02424	48809	2
59	28 8	31 52	51227	97571	53656	46344	02429	48773	1
60	28 0	32 0	51264	97567	53697	46303	02433	48736	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

108 Degs. Degs. 71.

Long. Sines, Tangents and Secants.

19 Degs. Degs. 160.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 28 0	2 32 0	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	60
1	27 52	32 8	51301	97563	53738	46262	02437	48699	59
2	27 44	32 16	51338	97558	53779	46221	02442	48662	58
3	27 36	32 24	51374	97554	53820	46180	02446	48626	57
4	27 28	32 32	51411	97550	53861	46139	02450	48589	56
5	9 27 20	2 32 40	9.51447	9.97545	9.53902	10.46098	10.02455	10.48553	55
6	27 12	32 48	51484	97541	53943	46057	02459	48516	54
7	27 4	32 56	51520	97536	53984	46016	02464	48480	53
8	26 56	33 4	51557	97532	54025	45975	02468	48443	52
9	26 48	33 12	51593	97528	54065	45935	02472	48407	51
10	9 26 40	2 33 20	9.51629	9.97523	9.54106	10.45894	10.02477	10.48371	50
11	26 32	33 28	51666	97519	54147	45853	02481	48334	49
12	26 24	33 36	51702	97515	54187	45813	02485	48298	48
13	26 16	33 44	51738	97510	54228	45772	02490	48262	47
14	26 8	33 52	51774	97506	54269	45731	02494	48226	46
15	9 26 0	2 34 0	9.51811	9.97501	9.54309	10.45691	10.02499	10.48189	45
16	25 52	34 8	51847	97497	54350	45650	02503	48153	44
17	25 44	34 16	51883	97492	54390	45610	02508	48117	43
18	25 36	34 24	51919	97488	54431	45569	02512	48081	42
19	25 28	34 32	51955	97484	54471	45529	02516	48045	41
20	9 25 20	2 34 40	9.51991	9.97479	9.54512	10.45488	10.02521	10.48009	40
21	25 12	34 48	52027	97475	54552	45448	02525	47973	39
22	25 4	34 56	52063	97470	54593	45407	02530	47937	38
23	24 56	35 4	52099	97466	54633	45367	02534	47901	37
24	24 48	35 12	52135	97461	54673	45327	02539	47865	36
25	9 24 40	2 35 20	9.52171	9.97457	9.54714	10.45286	10.02543	10.47829	35
26	24 32	35 28	52207	97453	54754	45246	02547	47793	34
27	24 24	35 36	52242	97448	54794	45206	02552	47758	33
28	24 16	35 44	52278	97444	54835	45165	02556	47722	32
29	24 8	35 52	52314	97439	54875	45125	02561	47686	31
30	9 24 0	2 36 0	9.52350	9.97435	9.54915	10.45085	10.02565	10.47650	30
31	23 52	36 8	52385	97430	54955	45045	02570	47615	29
32	23 44	36 16	52421	97426	54995	45005	02574	47579	28
33	23 36	36 24	52456	97421	55035	44965	02579	47544	27
34	23 28	36 32	52492	97417	55075	44925	02583	47508	26
35	9 23 20	2 36 40	9.52527	9.97412	9.55115	10.44885	10.02588	10.47473	25
36	23 12	36 48	52563	97408	55155	44845	02592	47437	24
37	23 4	36 56	52598	97403	55195	44805	02597	47402	23
38	22 56	37 4	52634	97399	55235	44765	02601	47366	22
39	22 48	37 12	52669	97394	55275	44725	02606	47331	21
40	9 22 40	2 37 20	9.52705	9.97390	9.55315	10.44685	10.02610	10.47295	20
41	22 32	37 28	52740	97385	55355	44645	02615	47260	19
42	22 24	37 36	52775	97381	55395	44605	02619	47225	18
43	22 16	37 44	52811	97376	55434	44566	02624	47189	17
44	22 8	37 52	52846	97372	55474	44526	02628	47154	16
45	9 22 0	2 38 0	9.52881	9.97367	9.55514	10.44486	10.02633	10.47119	15
46	21 52	38 8	52916	97363	55554	44446	02637	47084	14
47	21 44	38 16	52951	97358	55593	44407	02642	47049	13
48	21 36	38 24	52986	97353	55633	44367	02647	47014	12
49	21 28	38 32	53021	97349	55673	44327	02651	46979	11
50	9 21 20	2 38 40	9.53056	9.97344	9.55712	10.44288	10.02656	10.46944	10
51	21 12	38 48	53092	97340	55752	44248	02660	46908	9
52	21 4	38 56	53126	97335	55791	44209	02665	46874	8
53	20 56	39 4	53161	97331	55831	44169	02669	46839	7
54	20 48	39 12	53196	97326	55870	44130	02674	46804	6
55	9 20 40	2 39 20	9.53231	9.97322	9.55910	10.44090	10.02678	10.46769	5
56	20 32	39 28	53266	97317	55949	44051	02683	46734	4
57	20 24	39 36	53301	97312	55989	44011	02688	46699	3
58	20 16	39 44	53336	97308	56028	43972	02692	46664	2
59	20 8	39 52	53370	97303	56067	43933	02697	46630	1
60	20 0	40 0	53405	97299	56107	43893	02701	46595	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

109 Degs. Degs. 70.

TABLE XXVII.

Log. Sines, Tangents and Secants.

20 Degs. Degs. 159.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 20 0	2 40 0	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	60
1	19 52	40 8	53440	97294	56146	43854	02706	46560	59
2	19 44	40 16	53475	97289	56185	43815	02711	46525	58
3	19 36	40 24	53509	97285	56224	43776	02715	46491	57
4	19 28	40 32	53544	97280	56264	43736	02720	46456	56
5	9 19 20	2 40 40	9.53578	9.97276	9.56303	10.43697	10.02724	10.46422	55
6	19 12	40 48	53613	97271	56342	43658	02729	46387	54
7	19 4	40 56	53647	97266	56381	43619	02734	46353	53
8	18 56	41 4	53682	97262	56420	43580	02738	46318	52
9	18 48	41 12	53716	97257	56459	43541	02743	46284	51
10	9 18 40	2 41 20	9.53751	9.97252	9.56498	10.43502	10.02748	10.46249	50
11	18 32	41 28	53785	97248	56537	43463	02752	46215	49
12	18 24	41 36	53819	97243	56576	43424	02757	46181	48
13	18 16	41 44	53854	97238	56615	43385	02762	46146	47
14	18 8	41 52	53888	97234	56654	43346	02766	46112	46
15	9 18 0	2 42 0	9.53922	9.97229	9.56693	10.43307	10.02771	10.46078	45
16	17 52	42 8	53957	97224	56732	43268	02776	46043	44
17	17 44	42 16	53991	97220	56771	43229	02780	46009	43
18	17 36	42 24	54025	97215	56810	43190	02785	45975	42
19	17 28	42 32	54059	97210	56849	43151	02790	45941	41
20	9 17 20	2 42 40	9.54093	9.97206	9.56887	10.43113	10.02794	10.45907	40
21	17 12	42 48	54127	97201	56926	43074	02799	45873	39
22	17 4	42 56	54161	97196	56965	43035	02804	45839	38
23	16 56	43 4	54195	97192	57004	42996	02808	45805	37
24	16 48	43 12	54229	97187	57042	42958	02813	45771	36
25	9 16 40	2 43 20	9.54263	9.97182	9.57081	10.42919	10.02818	10.45737	35
26	16 32	43 28	54297	97178	57120	42880	02822	45703	34
27	16 24	43 36	54331	97173	57158	42842	02827	45669	33
28	16 16	43 44	54365	97168	57197	42803	02832	45635	32
29	16 8	43 52	54399	97163	57235	42765	02837	45601	31
30	9 16 0	2 44 0	9.54433	9.97159	9.57274	10.42726	10.02841	10.45567	30
31	15 52	44 8	54466	97154	57312	42688	02846	45534	29
32	15 44	44 16	54500	97149	57351	42649	02851	45500	28
33	15 36	44 24	54534	97145	57389	42611	02855	45466	27
34	15 28	44 32	54567	97140	57428	42572	02860	45433	26
35	9 15 20	2 44 40	9.54601	9.97135	9.57466	10.42534	10.02865	10.45399	25
36	15 12	44 48	54635	97130	57504	42496	02870	45365	24
37	15 4	44 56	54668	97126	57543	42457	02874	45332	23
38	14 56	45 4	54702	97121	57581	42419	02879	45298	22
39	14 48	45 12	54735	97116	57619	42381	02884	45265	21
40	9 14 40	2 45 20	9.54769	9.97111	9.57658	10.42342	10.02889	10.45231	20
41	14 32	45 28	54802	97107	57696	42304	02893	45198	19
42	14 24	45 36	54836	97102	57734	42266	02898	45164	18
43	14 16	45 44	54869	97097	57772	42228	02903	45131	17
44	14 8	45 52	54903	97092	57810	42190	02908	45097	16
45	9 14 0	2 46 0	9.54936	9.97087	9.57849	10.42151	10.02913	10.45064	15
46	13 52	46 8	54969	97083	57887	42113	02917	45031	14
47	13 44	46 16	55003	97078	57925	42075	02922	44997	13
48	13 36	46 24	55036	97073	57963	42037	02927	44964	12
49	13 28	46 32	55069	97068	58001	41999	02932	44931	11
50	9 13 20	2 46 40	9.55102	9.97063	9.58039	10.41961	10.02937	10.44898	10
51	13 12	46 48	55136	97059	58077	41923	02941	44864	9
52	13 4	46 56	55169	97054	58115	41885	02946	44831	8
53	12 56	47 4	55202	97049	58153	41847	02951	44798	7
54	12 48	47 12	55235	97044	58191	41809	02956	44765	6
55	9 12 40	2 47 20	9.55268	9.97039	9.58229	10.41771	10.02961	10.44732	5
56	12 32	47 28	55301	97035	58267	41733	02965	44699	4
57	12 24	47 36	55334	97030	58304	41696	02970	44666	3
58	12 16	47 44	55367	97025	58342	41658	02975	44633	2
59	12 8	47 52	55400	97020	58380	41620	02980	44600	1
60	12 0	48 0	55433	97015	58418	41582	02985	44567	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

110 Degs. Degs. 69.

TABLE XXVII.

Log. Sines, Tangents and Secants.

21 Degs. | Degs. 158.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	9 12 0	2 48 0	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
1	11 52	48 8	55466	97010	58455	41545	02990	44534	59
2	11 44	48 16	55499	97005	58493	41507	02995	44501	58
3	11 36	48 24	55532	97001	58531	41469	02999	44468	57
4	11 28	48 32	55564	96996	58569	41431	03004	44436	56
5	9 11 20	2 48 40	9.55597	9.96991	9.58606	10.41394	10.03009	10.44403	55
6	11 12	48 48	55630	96986	58644	41356	03014	44370	54
7	11 4	48 56	55663	96981	58681	41319	03019	44337	53
8	10 56	49 4	55695	96976	58719	41281	03024	44305	52
9	10 48	49 12	55728	96971	58757	41243	03029	44272	51
10	9 10 40	2 49 20	9.55761	9.96966	9.58794	10.41206	10.03034	10.44239	50
11	10 32	49 28	55793	96962	58832	41168	03038	44207	49
12	10 24	49 36	55826	96957	58869	41131	03043	44174	48
13	10 16	49 44	55858	96952	58907	41093	03048	44142	47
14	10 8	49 52	55891	96947	58944	41056	03053	44109	46
15	9 10 0	2 50 0	9.55923	9.96942	9.58981	10.41019	10.03058	10.44077	45
16	9 52	50 8	55956	96937	59019	40981	03063	44044	44
17	9 44	50 16	55988	96932	59056	40944	03068	44012	43
18	9 36	50 24	56021	96927	59094	40906	03073	43979	42
19	9 28	50 32	56053	96922	59131	40869	03078	43947	41
20	9 9 20	2 50 40	9.56085	9.96917	9.59168	10.40832	10.03083	10.43915	40
21	9 12	50 48	56118	96912	59205	40795	03088	43882	39
22	9 4	50 56	56150	96907	59243	40757	03093	43850	38
23	8 56	51 4	56182	96903	59280	40720	03097	43818	37
24	8 48	51 12	56215	96898	59317	40683	03102	43785	36
25	9 8 40	2 51 20	9.56247	9.96893	9.59354	10.40646	10.03107	10.43753	35
26	8 32	51 28	56279	96888	59391	40609	03112	43721	34
27	8 24	51 36	56311	96883	59429	40571	03117	43689	33
28	8 16	51 44	56343	96878	59466	40534	03122	43657	32
29	8 8	51 52	56375	96873	59503	40497	03127	43625	31
30	9 8 0	2 52 0	9.56408	9.96868	9.59540	10.40460	10.03132	10.43592	30
31	7 52	52 8	56440	96863	59577	40423	03137	43560	29
32	7 44	52 16	56472	96858	59614	40386	03142	43528	28
33	7 36	52 24	56504	96853	59651	40349	03147	43496	27
34	7 28	52 32	56536	96848	59688	40312	03152	43464	26
35	9 7 20	2 52 40	9.56568	9.96843	9.59725	10.40275	10.03157	10.43432	25
36	7 12	52 48	56599	96838	59762	40238	03162	43401	24
37	7 4	52 56	56631	96833	59799	40201	03167	43369	23
38	6 56	53 4	56663	96828	59835	40165	03172	43337	22
39	6 48	53 12	56695	96823	59872	40128	03177	43305	21
40	9 6 40	2 53 20	9.56727	9.96818	9.59909	10.40091	10.03182	10.43273	20
41	6 32	53 28	56759	96813	59946	40054	03187	43241	19
42	6 24	53 36	56790	96808	59983	40017	03192	43210	18
43	6 16	53 44	56822	96803	60019	39981	03197	43178	17
44	6 8	53 52	56854	96798	60056	39944	03202	43146	16
45	9 6 0	2 54 0	9.56886	9.96793	9.60093	10.39907	10.03207	10.43114	15
46	5 52	54 8	56917	96788	60130	39870	03212	43083	14
47	5 44	54 16	56949	96783	60166	39834	03217	43051	13
48	5 36	54 24	56980	96778	60203	39797	03222	43020	12
49	5 28	54 32	57012	96772	60240	39760	03228	42988	11
50	9 5 20	2 54 40	9.57044	9.96767	9.60276	10.39724	10.03233	10.42956	10
51	5 12	54 48	57075	96762	60313	39687	03238	42925	9
52	5 4	54 56	57107	96757	60349	39651	03243	42893	8
53	4 56	55 4	57138	96752	60386	39614	03248	42862	7
54	4 48	55 12	57169	96747	60422	39578	03253	42831	6
55	9 4 40	2 55 20	9.57201	9.96742	9.60459	10.39541	10.03258	10.42799	5
56	4 32	55 28	57232	96737	60495	39505	03263	42768	4
57	4 24	55 36	57264	96732	60532	39468	03268	42736	3
58	4 16	55 44	57295	96727	60568	39432	03273	42705	2
59	4 8	55 52	57326	96722	60605	39395	03278	42674	1
60	4 0	56 0	57358	96717	60641	39359	03283	42642	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

111 Degs. | Degs. 68.

TABLE XXVII.

Log. Sines, Tangents and Secants.

22 Degs. Degs. 157.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	9 4 0	2 56 0	9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	60
1	3 52	56 8	57389	96711	60677	39323	03289	42611	59
2	3 44	56 16	57420	96706	60714	39286	03294	42580	58
3	3 36	56 24	57451	96701	60750	39250	03299	42549	57
4	3 28	56 32	57482	96696	60786	39214	03304	42518	56
5	9 3 20	2 56 40	9.57514	9.96691	9.60823	10.39177	10.03309	10.42486	55
6	3 12	56 48	57545	96686	60859	39141	03314	42455	54
7	3 4	56 56	57576	96681	60895	39105	03319	42424	53
8	2 56	57 4	57607	96676	60931	39069	03324	42393	52
9	2 48	57 12	57638	96670	60967	39033	03330	42362	51
10	9 2 40	2 57 20	9.57669	9.96665	9.61004	10.38996	10.03335	10.42331	50
11	2 32	57 28	57700	96660	61040	38960	03340	42300	49
12	2 24	57 36	57731	96655	61076	38924	03345	42269	48
13	2 16	57 44	57762	96650	61112	38888	03350	42238	47
14	2 8	57 52	57793	96645	61148	38852	03355	42207	46
15	9 2 0	2 58 0	9.57824	9.96640	9.61184	10.38816	10.03360	10.42176	45
16	1 52	58 8	57855	96634	61220	38780	03366	42145	44
17	1 44	58 16	57885	96629	61256	38744	03371	42115	43
18	1 36	58 24	57916	96624	61292	38708	03376	42084	42
19	1 28	58 32	57947	96619	61328	38672	03381	42053	41
20	9 1 20	2 58 40	9.57978	9.96614	9.61364	10.38636	10.03386	10.42022	40
21	1 12	58 48	58008	96608	61400	38600	03392	41992	39
22	1 4	58 56	58039	96603	61436	38564	03397	41961	38
23	0 56	59 4	58070	96598	61472	38528	03402	41930	37
24	0 48	59 12	58101	96593	61508	38492	03407	41899	36
25	9 0 40	2 59 20	9.58131	9.96588	9.61544	10.38456	10.03412	10.41869	35
26	0 32	59 28	58162	96582	61579	38421	03418	41838	34
27	0 24	59 36	58192	96577	61615	38385	03423	41808	33
28	0 16	59 44	58223	96572	61651	38349	03428	41777	32
29	0 8	59 52	58253	96567	61687	38313	03433	41747	31
30	9 0 0	3 0 0	9.58284	9.96562	9.61722	10.38278	10.03438	10.41716	30
31	8 59 52	0 8	58314	96556	61758	38242	03444	41686	29
32	59 44	0 16	58345	96551	61794	38206	03449	41655	28
33	59 36	0 24	58375	96546	61830	38170	03454	41625	27
34	59 28	0 32	58406	96541	61865	38135	03459	41594	26
35	8 59 20	3 0 40	9.58436	9.96535	9.61901	10.38099	10.03465	10.41564	25
36	59 12	0 48	58467	96530	61936	38064	03470	41533	24
37	59 4	0 56	58497	96525	61972	38028	03475	41503	23
38	58 56	1 4	58527	96520	62008	37992	03480	41473	22
39	58 48	1 12	58557	96514	62043	37957	03486	41443	21
40	8 58 40	3 1 20	9.58588	9.96509	9.62079	10.37921	10.03491	10.41412	20
41	58 32	1 28	58618	96504	62114	37886	03496	41382	19
42	58 24	1 36	58648	96498	62150	37850	03502	41352	18
43	58 16	1 44	58678	96493	62185	37815	03507	41322	17
44	58 8	1 52	58709	96488	62221	37779	03512	41291	16
45	8 58 0	3 2 0	9.58739	9.96483	9.62256	10.37744	10.03517	10.41261	15
46	57 52	2 8	58769	96477	62292	37708	03523	41231	14
47	57 44	2 16	58799	96472	62327	37673	03528	41201	13
48	57 36	2 24	58829	96467	62362	37638	03533	41171	12
49	57 28	2 32	58859	96461	62398	37602	03539	41141	11
50	8 57 20	3 2 40	9.58889	9.96456	9.62433	10.37567	10.03544	10.41111	10
51	57 12	2 48	58919	96451	62468	37532	03549	41081	9
52	57 4	2 56	58949	96445	62504	37496	03555	41051	8
53	56 56	3 4	58979	96440	62539	37461	03560	41021	7
54	56 48	3 12	59009	96435	62574	37426	03565	40991	6
55	8 56 40	3 3 20	9.59039	9.96429	9.62609	10.37391	10.03571	10.40961	5
56	56 32	3 28	59069	96424	62645	37355	03576	40931	4
57	56 24	3 36	59098	96419	62680	37320	03581	40902	3
58	56 16	3 44	59128	96413	62715	37285	03587	40872	2
59	56 8	3 52	59158	96408	62750	37250	03592	40842	1
60	56 0	4 0	59188	96403	62785	37215	03597	40812	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Cotang.	Tangent.	Co-secant	Secant.	M

112 Degs. Degs. 67

Log. Sines, Tangents and Secants.

23 Degs. Degs. 156.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 56 0	3 4 0	9.59188	9.96403	9.62785	10.37215	10.03597	10.40812	60
1	55 52	4 8	59218	96397	62820	37180	03603	40782	59
2	55 44	4 16	59247	96392	62855	37145	03608	40753	58
3	55 36	4 24	59277	96387	62890	37110	03613	40723	57
4	55 28	4 32	59307	96381	62926	37074	03619	40693	56
5	8 55 20	3 4 40	9.59336	9.96376	9.62961	10.37039	10.03624	10.40664	55
6	55 12	4 48	59366	96370	62996	37004	03630	40634	54
7	55 4	4 56	59396	96365	63031	36969	03635	40604	53
8	54 56	5 4	59425	96360	63066	36934	03640	40575	52
9	54 48	5 12	59455	96354	63101	36899	03646	40545	51
10	8 54 40	3 5 20	9.59484	9.96349	9.63135	10.36865	10.03651	10.40516	50
11	54 32	5 28	59514	96343	63170	36830	03657	40486	49
12	54 24	5 36	59543	96338	63205	36795	03662	40457	48
13	54 16	5 44	59573	96333	63240	36760	03667	40427	47
14	54 8	5 52	59602	96327	63275	36725	03673	40398	46
15	8 54 0	3 6 0	9.59632	9.96322	9.63310	10.36690	10.03678	10.40368	45
16	53 52	6 8	59661	96316	63345	36655	03684	40339	44
17	53 44	6 16	59690	96311	63379	36621	03689	40310	43
18	53 36	6 24	59720	96305	63414	36586	03695	40280	42
19	53 28	6 32	59749	96300	63449	36551	03700	40251	41
20	8 53 20	3 6 40	9.59778	9.96294	9.63484	10.36516	10.03706	10.40222	40
21	53 12	6 48	59808	96289	63519	36481	03711	40192	39
22	53 4	6 56	59837	96284	63553	36447	03716	40163	38
23	52 56	7 4	59866	96278	63588	36412	03722	40134	37
24	52 48	7 12	59895	96273	63623	36377	03727	40105	36
25	8 52 40	3 7 20	9.59924	9.96267	9.63657	10.36343	10.03733	10.40076	35
26	52 32	7 28	59954	96262	63692	36308	03738	40046	34
27	52 24	7 36	59983	96256	63726	36274	03744	40017	33
28	52 16	7 44	60012	96251	63761	36239	03749	39988	32
29	52 8	7 52	60041	96245	63796	36204	03755	39959	31
30	8 52 0	3 8 0	9.60070	9.96240	9.63830	10.36170	10.03760	10.39930	30
31	51 52	8 8	60099	96234	63865	36135	03766	39901	29
32	51 44	8 16	60128	96229	63899	36101	03771	39872	28
33	51 36	8 24	60157	96223	63934	36066	03777	39843	27
34	51 28	8 32	60186	96218	63968	36032	03782	39814	26
35	8 51 20	3 8 40	9.60215	9.96212	9.64003	10.35997	10.03788	10.39785	25
36	51 12	8 48	60244	96207	64037	35963	03793	39756	24
37	51 4	8 56	60273	96201	64072	35928	03799	39727	23
38	50 56	9 4	60302	96196	64106	35894	03804	39698	22
39	50 48	9 12	60331	96190	64140	35860	03810	39669	21
40	8 50 40	3 9 20	9.60359	9.96185	9.64175	10.35825	10.03815	10.39641	20
41	50 32	9 28	60388	96179	64209	35791	03821	39612	19
42	50 24	9 36	60417	96174	64243	35757	03826	39583	18
43	50 16	9 44	60446	96168	64278	35722	03832	39554	17
44	50 8	9 52	60474	96162	64312	35688	03838	39526	16
45	8 50 0	3 10 0	9.60503	9.96157	9.64346	10.35654	10.03843	10.39497	15
46	49 52	10 8	60532	96151	64381	35619	03849	39468	14
47	49 44	10 16	60561	96146	64415	35585	03854	39439	13
48	49 36	10 24	60589	96140	64449	35551	03860	39411	12
49	49 28	10 32	60618	96135	64483	35517	03865	39382	11
50	8 49 20	3 10 40	9.60646	9.96129	9.64517	10.35483	10.03871	10.39354	10
51	49 12	10 48	60675	96123	64552	35448	03877	39325	9
52	49 4	10 56	60704	96118	64586	35414	03882	39296	8
53	48 56	11 4	60732	96112	64620	35380	03888	39268	7
54	48 48	11 12	60761	96107	64654	35346	03893	39239	6
55	8 48 40	3 11 20	9.60789	9.96101	9.64688	10.35312	10.03899	10.39211	5
56	48 32	11 28	60818	96095	64722	35278	03905	39182	4
57	48 24	11 36	60846	96090	64756	35244	03910	39154	3
58	48 16	11 44	60875	96084	64790	35210	03916	39125	2
59	48 8	11 52	60903	96079	64824	35176	03921	39097	1
60	48 0	12 0	60931	96073	64858	35142	03927	39069	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

113 Degs. Degs. 66.

TABLE XXVII.

Log. Sines, Tangents and Secants.

24 Degs. Degs. 155.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 48 0	3 12 0	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069	60
1	47 52	12 8	60960	96067	64892	35108	03933	39040	59
2	47 44	12 16	60988	96062	64926	35074	03938	39012	58
3	47 36	12 24	61016	96056	64960	35040	03944	38984	57
4	47 28	12 32	61045	96050	64994	35006	03950	38955	56
5	8 47 20	3 12 40	9.61073	9.96045	9.65028	10.34972	10.03955	10.38927	55
6	47 12	12 48	61101	96039	65062	34938	03961	38899	54
7	47 4	12 56	61129	96034	65096	34904	03966	38871	53
8	46 56	13 4	61158	96028	65130	34870	03972	38842	52
9	46 48	13 12	61186	96022	65164	34836	03978	38814	51
10	8 46 40	3 13 20	9.61214	9.96017	9.65197	10.34803	10.03983	10.38786	50
11	46 32	13 28	61242	96011	65231	34769	03989	38758	49
12	46 24	13 36	61270	96005	65265	34735	03995	38730	48
13	46 16	13 44	61298	96000	65299	34701	04000	38702	47
14	46 8	13 52	61326	95994	65333	34667	04006	38674	46
15	8 46 0	3 14 0	9.61354	9.95988	9.65366	10.34634	10.04012	10.38646	45
16	45 52	14 8	61382	95982	65400	34600	04018	38618	44
17	45 44	14 16	61411	95977	65434	34566	04023	38589	43
18	45 36	14 24	61438	95971	65467	34533	04029	38562	42
19	45 28	14 32	61466	95965	65501	34499	04035	38534	41
20	8 45 20	3 14 40	9.61494	9.95960	9.65535	10.34465	10.04040	10.38506	40
21	45 12	14 48	61522	95954	65568	34432	04046	38478	39
22	45 4	14 56	61550	95948	65602	34398	04052	38450	38
23	44 56	15 4	61578	95942	65636	34364	04058	38422	37
24	44 48	15 12	61606	95937	65669	34331	04063	38394	36
25	8 44 40	3 15 20	9.61634	9.95931	9.65703	10.34297	10.04069	10.38366	35
26	44 32	15 28	61662	95925	65736	34264	04075	38338	34
27	44 24	15 36	61689	95920	65770	34230	04080	38311	33
28	44 16	15 44	61717	95914	65803	34197	04086	38283	32
29	44 8	15 52	61745	95908	65837	34163	04092	38255	31
30	8 44 0	3 16 0	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
31	43 52	16 8	61800	95897	65904	34096	04103	38200	29
32	43 44	16 16	61828	95891	65937	34063	04109	38172	28
33	43 36	16 24	61856	95885	65971	34029	04115	38144	27
34	43 28	16 32	61883	95879	66004	33996	04121	38117	26
35	8 43 20	3 16 40	9.61911	9.95873	9.66038	10.33962	10.04127	10.38089	25
36	43 12	16 48	61939	95868	66071	33929	04132	38061	24
37	43 4	16 56	61966	95862	66104	33896	04138	38034	23
38	42 56	17 4	61994	95856	66138	33862	04144	38006	22
39	42 48	17 12	62021	95850	66171	33829	04150	37979	21
40	8 42 40	3 17 20	9.62049	9.95844	9.66204	10.33796	10.04156	10.37951	20
41	42 32	17 28	62076	95839	66238	33762	04161	37924	19
42	42 24	17 36	62104	95833	66271	33729	04167	37896	18
43	42 16	17 44	62131	95827	66304	33696	04173	37869	17
44	42 8	17 52	62159	95821	66337	33663	04179	37841	16
45	8 42 0	3 18 0	9.62186	9.95815	9.66371	10.33629	10.04185	10.37814	15
46	41 52	18 8	62214	95810	66404	33596	04190	37786	14
47	41 44	18 16	62241	95804	66437	33563	04196	37759	13
48	41 36	18 24	62268	95798	66470	33530	04202	37732	12
49	41 28	18 32	62296	95792	66503	33497	04208	37704	11
50	8 41 20	3 18 40	9.62323	9.95786	9.66537	10.33463	10.04214	10.37677	10
51	41 12	18 48	62350	95780	66570	33430	04220	37650	9
52	41 4	18 56	62377	95775	66603	33397	04225	37623	8
53	40 56	19 4	62405	95769	66636	33364	04231	37595	7
54	40 48	19 12	62432	95763	66669	33331	04237	37568	6
55	8 40 40	3 19 20	9.62459	9.95757	9.66702	10.33298	10.04243	10.37541	5
56	40 32	19 28	62486	95751	66735	33265	04249	37514	4
57	40 24	19 36	62513	95745	66768	33232	04255	37487	3
58	40 16	19 44	62541	95739	66801	33199	04261	37459	2
59	40 8	19 52	62568	95733	66834	33166	04267	37432	1
60	40 0	20 0	62595	95728	66867	33133	04272	37405	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

114 Degs. Degs. 65.

TABLE XXVII.

Log. Sines, Tangents and Secants.

25 Degs. Degs. 154.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 40 0	3 20 0	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	60
1	39 52	20 8	62622	95722	66900	33100	04278	37378	59
2	39 44	20 16	62649	95716	66933	33067	04284	37351	58
3	39 36	20 24	62676	95710	66966	33034	04290	37324	57
4	39 28	20 32	62703	95704	66999	33001	04296	37297	56
5	8 39 20	3 20 40	9.62730	9.95698	9.67032	10.32968	10.04302	10.37270	55
6	39 12	20 48	62757	95692	67065	32935	04308	37243	54
7	39 4	20 56	62784	95686	67098	32902	04314	37216	53
8	38 56	21 4	62811	95680	67131	32869	04320	37189	52
9	38 48	21 12	62838	95674	67163	32837	04326	37162	51
10	8 38 40	3 21 20	9.62865	9.95668	9.67196	10.32804	10.04332	10.37135	50
11	38 32	21 28	62892	95663	67229	32771	04337	37108	49
12	38 24	21 36	62918	95657	67262	32738	04343	37082	48
13	38 16	21 44	62945	95651	67295	32705	04349	37055	47
14	38 8	21 52	62972	95645	67327	32673	04355	37028	46
15	8 38 0	3 22 0	9.62999	9.95639	9.67360	10.32640	10.04361	10.37001	45
16	37 52	22 8	63026	95633	67393	32607	04367	36974	44
17	37 44	22 16	63052	95627	67426	32574	04373	36948	43
18	37 36	22 24	63079	95621	67458	32542	04379	36921	42
19	37 28	22 32	63106	95615	67491	32509	04385	36894	41
20	8 37 20	3 22 40	9.63133	9.95609	9.67524	10.32476	10.04391	10.36867	40
21	37 12	22 48	63159	95603	67556	32444	04397	36841	39
22	37 4	22 56	63186	95597	67589	32411	04403	36814	38
23	36 56	23 4	63213	95591	67622	32378	04409	36787	37
24	36 48	23 12	63239	95585	67654	32346	04415	36761	36
25	8 36 40	3 23 20	9.63266	9.95579	9.67687	10.32313	10.04421	10.36734	35
26	36 32	23 28	63292	95573	67719	32281	04427	36708	34
27	36 24	23 36	63319	95567	67752	32248	04433	36681	33
28	36 16	23 44	63345	95561	67785	32215	04439	36655	32
29	36 8	23 52	63372	95555	67817	32183	04445	36628	31
30	8 36 0	3 24 0	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30
31	35 52	24 8	63425	95543	67882	32118	04457	36575	29
32	35 44	24 16	63451	95537	67915	32085	04463	36549	28
33	35 36	24 24	63478	95531	67947	32053	04469	36522	27
34	35 28	24 32	63504	95525	67980	32020	04475	36496	26
35	8 35 20	3 24 40	9.63531	9.95519	9.68012	10.31988	10.04481	10.36469	25
36	35 12	24 48	63557	95513	68044	31956	04487	36443	24
37	35 4	24 56	63583	95507	68077	31923	04493	36417	23
38	34 56	25 4	63610	95500	68109	31891	04500	36390	22
39	34 48	25 12	63636	95494	68142	31858	04506	36364	21
40	8 34 40	3 25 20	9.63662	9.95488	9.68174	10.31826	10.04512	10.36338	20
41	34 32	25 28	63689	95482	68206	31794	04518	36311	19
42	34 24	25 36	63715	95476	68239	31761	04524	36285	18
43	34 16	25 44	63741	95470	68271	31729	04530	36259	17
44	34 8	25 52	63767	95464	68303	31697	04536	36233	16
45	8 34 0	3 26 0	9.63794	9.95458	9.68336	10.31664	10.04542	10.36206	15
46	33 52	26 8	63820	95452	68368	31632	04548	36180	14
47	33 44	26 16	63846	95446	68400	31600	04554	36154	13
48	33 36	26 24	63872	95440	68432	31568	04560	36128	12
49	33 28	26 32	63898	95434	68465	31535	04566	36102	11
50	8 33 20	3 26 40	9.63924	9.95427	9.68497	10.31503	10.04573	10.36076	10
51	33 12	26 48	63950	95421	68529	31471	04579	36050	9
52	33 4	26 56	63976	95415	68561	31439	04585	36024	8
53	32 56	27 4	64002	95409	68593	31407	04591	35998	7
54	32 48	27 12	64028	95403	68626	31374	04597	35972	6
55	8 32 40	3 27 20	9.64054	9.95397	9.68658	10.31342	10.04603	10.35946	5
56	32 32	27 28	64080	95391	68690	31310	04609	35920	4
57	32 24	27 36	64106	95384	68722	31278	04616	35894	3
58	32 16	27 44	64132	95378	68754	31246	04622	35868	2
59	32 8	27 52	64158	95372	68786	31214	04628	35842	1
60	32 0	28 0	64184	95366	68818	31182	04634	35816	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

115 Degs. Degs. 64.

TABLE XXVII.

Log. Sines, Tangents and Secants.

26 Degs. Degs. 153.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 32 0	3 28 0	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	60
1	31 52	28 8	64210	95360	68850	31150	04640	35790	59
2	31 44	28 16	64236	95354	68882	31118	04646	35764	58
3	31 36	28 24	64262	95348	68914	31086	04652	35738	57
4	31 28	28 32	64288	95341	68946	31054	04659	35712	56
5	8 31 20	3 28 40	9.64313	9.95335	9.68978	10.31022	10.04665	10.35687	55
6	31 12	28 48	64339	95329	69010	30990	04671	35661	54
7	31 4	28 56	64365	95323	69042	30958	04677	35635	53
8	30 56	29 4	64391	95317	69074	30926	04683	35609	52
9	30 48	29 12	64417	95310	69106	30894	04690	35583	51
10	8 30 40	3 29 20	9.64442	9.95304	9.69138	10.30862	10.04696	10.35558	50
11	30 32	29 28	64468	95298	69170	30830	04702	35532	49
12	30 24	29 36	64494	95292	69202	30798	04708	35506	48
13	30 16	29 44	64519	95286	69234	30766	04714	35481	47
14	30 8	29 52	64545	95279	69266	30734	04721	35455	46
15	8 30 0	3 30 0	9.64571	9.95273	9.69298	10.30702	10.04727	10.35429	45
16	29 52	30 8	64596	95267	69329	30671	04733	35404	44
17	29 44	30 16	64622	95261	69361	30639	04739	35378	43
18	29 36	30 24	64647	95254	69393	30607	04746	35353	42
19	29 28	30 32	64673	95248	69425	30575	04752	35327	41
20	8 29 20	3 30 40	9.64698	9.95242	9.69457	10.30543	10.04758	10.35302	40
21	29 12	30 48	64724	95236	69488	30512	04764	35276	39
22	29 4	30 56	64749	95229	69520	30480	04771	35251	38
23	28 56	31 4	64775	95223	69552	30448	04777	35225	37
24	28 48	31 12	64800	95217	69584	30416	04783	35200	36
25	8 28 40	3 31 20	9.64826	9.95211	9.69615	10.30385	10.04789	10.35174	35
26	28 32	31 28	64851	95204	69647	30353	04796	35149	34
27	28 24	31 36	64877	95198	69679	30321	04802	35123	33
28	28 16	31 44	64902	95192	69710	30290	04808	35098	32
29	28 8	31 52	64927	95185	69742	30258	04815	35073	31
30	8 28 0	3 32 0	9.64953	9.95179	9.69774	10.30226	10.04821	10.35047	30
31	27 52	32 8	64978	95173	69805	30195	04827	35022	29
32	27 44	32 16	65003	95167	69837	30163	04833	34997	28
33	27 36	32 24	65029	95160	69868	30132	04840	34971	27
34	27 28	32 32	65054	95154	69900	30100	04846	34946	26
35	8 27 20	3 32 40	9.65079	9.95148	9.69932	10.30068	10.04852	10.34921	25
36	27 12	32 48	65104	95141	69963	30037	04859	34896	24
37	27 4	32 56	65130	95135	69995	30005	04865	34870	23
38	26 56	33 4	65155	95129	70026	29974	04871	34845	22
39	26 48	33 12	65180	95122	70058	29942	04878	34820	21
40	8 26 40	3 33 20	9.65205	9.95116	9.70089	10.29911	10.04884	10.34795	20
41	26 32	33 28	65230	95110	70121	29879	04890	34770	19
42	26 24	33 36	65255	95103	70152	29848	04897	34745	18
43	26 16	33 44	65281	95097	70184	29816	04903	34719	17
44	26 8	33 52	65306	95090	70215	29785	04910	34694	16
45	8 26 0	3 34 0	9.65331	9.95084	9.70247	10.29753	10.04916	10.34669	15
46	25 52	34 8	65356	95078	70278	29722	04922	34644	14
47	25 44	34 16	65381	95071	70309	29691	04929	34619	13
48	25 36	34 24	65406	95065	70341	29659	04935	34594	12
49	25 28	34 32	65431	95059	70372	29628	04941	34569	11
50	8 25 20	3 34 40	9.65456	9.95052	9.70404	10.29596	10.04948	10.34544	10
51	25 12	34 48	65481	95046	70435	29565	04954	34519	9
52	25 4	34 56	65506	95039	70466	29534	04961	34494	8
53	24 56	35 4	65531	95033	70498	29502	04967	34469	7
54	24 48	35 12	65556	95027	70529	29471	04973	34444	6
55	8 24 40	3 35 20	9.65580	9.95020	9.70560	10.29440	10.04980	10.34420	5
56	24 32	35 28	65605	95014	70592	29408	04986	34395	4
57	24 24	35 36	65630	95007	70623	29377	04993	34370	3
58	24 16	35 44	65655	95001	70654	29346	04999	34345	2
59	24 8	35 52	65680	94995	70685	29315	05005	34320	1
60	24 0	36 0	65705	94988	70717	29283	05012	34295	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

116 Degs. Degs. 63.

Log. Sines, Tangents and Secants.

27 Degs. Degs. 152.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 24 0	3 36 0	9.65705	9.94988	9.70717	10.29283	10.05012	10.34295	60
1	23 52	36 8	65729	94982	70748	29252	05018	34271	59
2	23 44	36 16	65754	94975	70779	29221	05025	34246	58
3	23 36	36 24	65779	94969	70810	29190	05031	34221	57
4	23 28	36 32	65804	94962	70841	29159	05038	34196	56
5	8 23 20	3 36 40	9.65828	9.94956	9.70873	10.29127	10.05044	10.34172	55
6	23 12	36 48	65853	94949	70904	29096	05051	34147	54
7	23 4	36 56	65878	94943	70935	29065	05057	34122	53
8	22 56	37 4	65902	94936	70966	29034	05064	34098	52
9	22 48	37 12	65927	94930	70997	29003	05070	34073	51
10	8 22 40	3 37 20	9.65952	9.94923	9.71028	10.28972	10.05077	10.34048	50
11	22 32	37 28	65976	94917	71059	28941	05083	34024	49
12	22 24	37 36	66001	94911	71090	28910	05089	33999	48
13	22 16	37 44	66025	94904	71121	28879	05096	33975	47
14	22 8	37 52	66050	94898	71153	28847	05102	33950	46
15	8 22 0	3 38 0	9.66075	9.94891	9.71184	10.28816	10.05109	10.33925	45
16	21 52	38 8	66099	94885	71215	28785	05115	33901	44
17	21 44	38 16	66124	94878	71246	28754	05122	33876	43
18	21 36	38 24	66148	94871	71277	28723	05129	33852	42
19	21 28	38 32	66173	94865	71308	28692	05135	33827	41
20	8 21 20	3 38 40	9.66197	9.94858	9.71339	10.28661	10.05142	10.33803	40
21	21 12	38 48	66221	94852	71370	28630	05148	33779	39
22	21 4	38 56	66246	94845	71401	28599	05155	33754	38
23	20 56	39 4	66270	94839	71431	28569	05161	33730	37
24	20 48	39 12	66295	94832	71462	28538	05168	33705	36
25	8 20 40	3 39 20	9.66319	9.94826	9.71493	10.28507	10.05174	10.33681	35
26	20 32	39 28	66343	94819	71524	28476	05181	33657	34
27	20 24	39 36	66368	94813	71555	28445	05187	33632	33
28	20 16	39 44	66392	94806	71586	28414	05194	33608	32
29	20 8	39 52	66416	94799	71617	28383	05201	33584	31
30	8 20 0	3 40 0	9.66441	9.94793	9.71648	10.28352	10.05207	10.33559	30
31	19 52	40 8	66465	94786	71679	28321	05214	33535	29
32	19 44	40 16	66489	94780	71709	28291	05220	33511	28
33	19 36	40 24	66513	94773	71740	28260	05227	33487	27
34	19 28	40 32	66537	94767	71771	28229	05233	33463	26
35	8 19 20	3 40 40	9.66562	9.94760	9.71802	10.28198	10.05240	10.33438	25
36	19 12	40 48	66586	94753	71833	28167	05247	33414	24
37	19 4	40 56	66610	94747	71863	28137	05253	33390	23
38	18 56	41 4	66634	94740	71894	28106	05260	33366	22
39	18 48	41 12	66658	94734	71925	28075	05266	33342	21
40	8 18 40	3 41 20	9.66682	9.94727	9.71955	10.28045	10.05273	10.33318	20
41	18 32	41 28	66706	94720	71986	28014	05280	33294	19
42	18 24	41 36	66731	94714	72017	27983	05286	33269	18
43	18 16	41 44	66755	94707	72048	27952	05293	33245	17
44	18 8	41 52	66779	94700	72078	27922	05300	33221	16
45	8 18 0	3 42 0	9.66803	9.94694	9.72109	10.27891	10.05306	10.33197	15
46	17 52	42 8	66827	94687	72140	27860	05313	33173	14
47	17 44	42 16	66851	94680	72170	27830	05320	33149	13
48	17 36	42 24	66875	94674	72201	27799	05326	33125	12
49	17 28	42 32	66899	94667	72231	27769	05333	33101	11
50	8 17 20	3 42 40	9.66922	9.94660	9.72262	10.27738	10.05340	10.33078	10
51	17 12	42 48	66946	94654	72293	27707	05346	33054	9
52	17 4	42 56	66970	94647	72323	27677	05353	33030	8
53	16 56	43 4	66994	94640	72354	27646	05360	33006	7
54	16 48	43 12	67018	94634	72384	27616	05366	32982	6
55	8 16 40	3 43 20	9.67042	9.94627	9.72415	10.27585	10.05373	10 32958	5
56	16 32	43 28	67066	94620	72445	27555	05380	32934	4
57	16 24	43 36	67090	94614	72476	27524	05386	32910	3
58	16 16	43 44	67113	94607	72506	27494	05393	32887	2
59	16 8	43 52	67137	94600	72537	27463	05400	32863	1
60	16 0	44 0	67161	94593	72567	27433	05407	32839	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

117 Degs. Degs. 62.

TABLE XXVII.

Log. Sines, Tangents and Secants.

28 Degs. Degs. 151.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 16 0	3 44 0	9.67161	9.94593	9.72567	10.27433	10.05407	10.32839	60
1	15 52	44 8	67185	94587	72598	27402	05413	32815	59
2	15 44	44 16	67208	94580	72628	27372	05420	32792	58
3	15 36	44 24	67232	94573	72659	27341	05427	32768	57
4	15 28	44 32	67256	94567	72689	27311	05433	32744	56
5	8 15 20	3 44 40	9.67280	9.94560	9.72720	10.27280	10.05440	10.32720	55
6	15 12	44 48	67303	94553	72750	27250	05447	32697	54
7	15 4	44 56	67327	94546	72780	27220	05454	32673	53
8	14 56	45 4	67350	94540	72811	27189	05460	32650	52
9	14 48	45 12	67374	94533	72841	27159	05467	32626	51
10	8 14 40	3 45 20	9.67398	9.94526	9.72872	10.27128	10.05474	10.32602	50
11	14 32	45 28	67421	94519	72902	27098	05481	32579	49
12	14 24	45 36	67445	94513	72932	27068	05487	32555	48
13	14 16	45 44	67468	94506	72963	27037	05494	32532	47
14	14 8	45 52	67492	94499	72993	27007	05501	32508	46
15	8 14 0	3 46 0	9.67515	9.94492	9.73023	10.26977	10.05508	10.32485	45
16	13 52	46 8	67539	94485	73054	26946	05515	32461	44
17	13 44	46 16	67562	94479	73084	26916	05521	32438	43
18	13 36	46 24	67586	94472	73114	26886	05528	32414	42
19	13 28	46 32	67609	94465	73144	26856	05535	32391	41
20	8 13 20	3 46 40	9.67633	9.94458	9.73175	10.26825	10.05542	10.32367	40
21	13 12	46 48	67656	94451	73205	26795	05549	32344	39
22	13 4	46 56	67680	94445	73235	26765	05555	32320	38
23	12 56	47 4	67703	94438	73265	26735	05562	32297	37
24	12 48	47 12	67726	94431	73295	26705	05569	32274	36
25	8 12 40	3 47 20	9.67750	9.94424	9.73326	10.26674	10.05576	10.32250	35
26	12 32	47 28	67773	94417	73356	26644	05583	32227	34
27	12 24	47 36	67796	94410	73386	26614	05590	32204	33
28	12 16	47 44	67820	94404	73416	26584	05596	32180	32
29	12 8	47 52	67843	94397	73446	26554	05603	32157	31
30	8 12 0	3 48 0	9.67866	9.94390	9.73476	10.26524	10.05610	10.32134	30
31	11 52	48 8	67890	94383	73507	26493	05617	32110	29
32	11 44	48 16	67913	94376	73537	26463	05624	32087	28
33	11 36	48 24	67936	94369	73567	26433	05631	32064	27
34	11 28	48 32	67959	94362	73597	26403	05638	32041	26
35	8 11 20	3 48 40	9.67982	9.94355	9.73627	10.26373	10.05645	10.32018	25
36	11 12	48 48	68006	94349	73657	26343	05651	31994	24
37	11 4	48 56	68029	94342	73687	26313	05658	31971	23
38	10 56	49 4	68052	94335	73717	26283	05665	31948	22
39	10 48	49 12	68075	94328	73747	26253	05672	31925	21
40	8 10 40	3 49 20	9.68098	9.94321	9.73777	10.26223	10.05679	10.31902	20
41	10 32	49 28	68121	94314	73807	26193	05686	31879	19
42	10 24	49 36	68144	94307	73837	26163	05693	31856	18
43	10 16	49 44	68167	94300	73867	26133	05700	31833	17
44	10 8	49 52	68190	94293	73897	26103	05707	31810	16
45	8 10 0	3 50 0	9.68213	9.94286	9.73927	10.26073	10.05714	10.31787	15
46	9 52	50 8	68237	94279	73957	26043	05721	31763	14
47	9 44	50 16	68260	94273	73987	26013	05727	31740	13
48	9 36	50 24	68283	94266	74017	25983	05734	31717	12
49	9 28	50 32	68305	94259	74047	25953	05741	31695	11
50	8 9 20	3 50 40	9.68328	9.94252	9.74077	10.25923	10.05748	10.31672	10
51	9 12	50 48	68351	94245	74107	25893	05755	31649	9
52	9 4	50 56	68374	94238	74137	25863	05762	31626	8
53	8 56	51 4	68397	94231	74166	25834	05769	31603	7
54	8 48	51 12	68420	94224	74196	25804	05776	31580	6
55	8 8 40	3 51 20	9.68443	9.94217	9.74226	10.25774	10.05783	10.31557	5
56	8 32	51 28	68466	94210	74256	25744	05790	31534	4
57	8 24	51 36	68489	94203	74286	25714	05797	31511	3
58	8 16	51 44	68512	94196	74316	25684	05804	31488	2
59	8 8	51 52	68534	94189	74345	25655	05811	31466	1
60	8 0	52 0	68557	94182	74375	25625	05818	31443	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

118 Degs. Degs. 61.

Log. Sines, Tangents and Secants.

29 Degs. | Degs. 150

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	8 8 0	3 52 0	9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	60
1	7 52	52 8	68580	94175	74405	25595	05825	31420	59
2	7 44	52 16	68603	94168	74435	25565	05832	31397	58
3	7 36	52 24	68625	94161	74465	25535	05839	31375	57
4	7 28	52 32	68648	94154	74494	25506	05846	31352	56
5	8 7 20	3 52 40	9.68671	9.94147	9.74524	10.25476	10.05853	10.31329	55
6	7 12	52 48	68694	94140	74554	25446	05860	31306	54
7	7 4	52 56	68716	94133	74583	25417	05867	31284	53
8	6 56	53 4	68739	94126	74613	25387	05874	31261	52
9	6 48	53 12	68762	94119	74643	25357	05881	31238	51
10	8 6 40	3 53 20	9.68784	9.94112	9.74673	10.25327	10.05888	10.31216	50
11	6 32	53 28	68807	94105	74702	25298	05895	31193	49
12	6 24	53 36	68829	94098	74732	25268	05902	31171	48
13	6 16	53 44	68852	94090	74762	25238	05910	31148	47
14	6 8	53 52	68875	94083	74791	25209	05917	31125	46
15	8 6 0	3 54 0	9.68897	9.94076	9.74821	10.25179	10.05924	10.31103	45
16	5 52	54 8	68920	94069	74851	25149	05931	31080	44
17	5 44	54 16	68942	94062	74880	25120	05938	31058	43
18	5 36	54 24	68965	94055	74910	25090	05945	31035	42
19	5 28	54 32	68987	94048	74939	25061	05952	31013	41
20	8 5 20	3 54 40	9.69010	9.94041	9.74969	10.25031	10.05959	10.30990	40
21	5 12	54 48	69032	94034	74998	25002	05966	30968	39
22	5 4	54 56	69055	94027	75028	24972	05973	30945	38
23	4 56	55 4	69077	94020	75058	24942	05980	30923	37
24	4 48	55 12	69100	94012	75087	24913	05988	30900	36
25	8 4 40	3 55 20	9.69122	9.94005	9.75117	10.24883	10.05995	10.30878	35
26	4 32	55 28	69144	93998	75146	24854	06002	30856	34
27	4 24	55 36	69167	93991	75176	24824	06009	30833	33
28	4 16	55 44	69189	93984	75205	24795	06016	30811	32
29	4 8	55 52	69212	93977	75235	24765	06023	30788	31
30	8 4 0	3 56 0	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
31	3 52	56 8	69256	93963	75294	24706	06037	30744	29
32	3 44	56 16	69279	93955	75323	24677	06045	30721	28
33	3 36	56 24	69301	93948	75353	24647	06052	30699	27
34	3 28	56 32	69323	93941	75382	24618	06059	30677	26
35	8 3 20	3 56 40	9.69345	9.93934	9.75411	10.24589	10.06066	10.30655	25
36	3 12	56 48	69368	93927	75441	24559	06073	30632	24
37	3 4	56 56	69390	93920	75470	24530	06080	30610	23
38	2 56	57 4	69412	93912	75500	24500	06088	30588	22
39	2 48	57 12	69434	93905	75529	24471	06095	30566	21
40	8 2 40	3 57 20	9.69456	9.93898	9.75558	10.24442	10.06102	10.30544	20
41	2 32	57 28	69479	93891	75588	24412	06109	30521	19
42	2 24	57 36	69501	93884	75617	24383	06116	30499	18
43	2 16	57 44	69523	93876	75647	24353	06124	30477	17
44	2 8	57 52	69545	93869	75676	24324	06131	30455	16
45	8 2 0	3 58 0	9.69567	9.93862	9.75705	10.24295	10.06138	10.30433	15
46	1 52	58 8	69589	93855	75735	24265	06145	30411	14
47	1 44	58 16	69611	93847	75764	24236	06153	30389	13
48	1 36	58 24	69633	93840	75793	24207	06160	30367	12
49	1 28	58 32	69655	93833	75822	24178	06167	30345	11
50	8 1 20	3 58 40	9.69677	9.93826	9.75852	10.24148	10.06174	10.30323	10
51	1 12	58 48	69699	93819	75881	24119	06181	30301	9
52	1 4	58 56	69721	93811	75910	24090	06189	30279	8
53	0 56	59 4	69743	93804	75939	24061	06196	30257	7
54	0 48	59 12	69765	93797	75969	24031	06203	30235	6
55	8 0 40	3 59 20	9.69787	9.93789	9.75998	10.24002	10.06211	10.30213	5
56	0 32	59 28	69809	93782	76027	23973	06218	30191	4
57	0 24	59 36	69831	93775	76056	23944	06225	30169	3
58	0 16	59 44	69853	93768	76086	23914	06232	30147	2
59	0 8	59 52	69875	93760	76115	23885	06240	30125	1
60	0 0	4 0 0	69897	93753	76144	23856	06247	30103	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

119 Degs. | Degs. 60

TABLE XXVII.

Log. Sines, Tangents and Secants.

30 Degs. Degs. 149.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	8 0 0	4 0 0	9.69897	9.93753	9.76144	10.23856	10.06247	10.30103	60
1	7 59 52	0 8	69919	93746	76173	23827	06254	30081	59
2	59 44	0 16	69941	93738	76202	23798	06262	30059	58
3	59 36	0 24	69963	93731	76231	23769	06269	30037	57
4	59 28	0 32	69984	93724	76261	23739	06276	30016	56
5	7 59 20	4 0 40	9.70006	9.93717	9.76290	10.23710	10.06283	10.29994	55
6	59 12	0 48	70028	93709	76319	23681	06291	29972	54
7	59 4	0 56	70050	93702	76348	23652	06298	29950	53
8	58 56	1 4	70072	93695	76377	23623	06305	29928	52
9	58 48	1 12	70093	93687	76406	23594	06313	29907	51
10	7 58 40	4 1 20	9.70115	9.93680	9.76435	10.23565	10.06320	10.29885	50
11	58 32	1 28	70137	93673	76464	23536	06327	29863	49
12	58 24	1 36	70159	93665	76493	23507	06335	29841	48
13	58 16	1 44	70180	93658	76522	23478	06342	29820	47
14	58 8	1 52	70202	93650	76551	23449	06350	29798	46
15	7 58 0	4 2 0	9.70224	9.93643	9.76580	10.23420	10.06357	10.29776	45
16	57 52	2 8	70245	93636	76609	23391	06364	29755	44
17	57 44	2 16	70267	93628	76639	23361	06372	29733	43
18	57 36	2 24	70288	93621	76668	23332	06379	29712	42
19	57 28	2 32	70310	93614	76697	23303	06386	29690	41
20	7 57 20	4 2 40	9.70332	9.93606	9.76725	10.23275	10.06394	10.29668	40
21	57 12	2 48	70353	93599	76754	23246	06401	29647	39
22	57 4	2 56	70375	93591	76783	23217	06409	29625	38
23	56 56	3 4	70396	93584	76812	23188	06416	29604	37
24	56 48	3 12	70418	93577	76841	23159	06423	29582	36
25	7 56 40	4 3 20	9.70439	9 93569	9.76870	10.23130	10.06431	10.29561	35
26	56 32	3 28	70461	93562	76899	23101	06438	29539	34
27	56 24	3 36	70482	93554	76928	23072	06446	29518	33
28	56 16	3 44	70504	93547	76957	23043	06453	29496	32
29	56 8	3 52	70525	93539	76986	23014	06461	29475	31
30	7 56 0	4 4 0	9.70547	9.93532	9.77015	10.22985	10.06468	10.29453	30
31	55 52	4 8	70568	93525	77044	22956	06475	29432	29
32	55 44	4 16	70590	93517	77073	22927	06483	29410	28
33	55 36	4 24	70611	93510	77101	22899	06490	29389	27
34	55 28	4 32	70633	93502	77130	22870	06498	29367	26
35	7 55 20	4 4 40	9.70654	9.93495	9.77159	10.22841	10.06505	10.29346	25
36	55 12	4 48	70675	93487	77188	22812	06513	29325	24
37	55 4	4 56	70697	93480	77217	22783	06520	29303	23
38	54 56	5 4	70718	93472	77246	22754	06528	29282	22
39	54 48	5 12	70739	93465	77274	22726	06535	29261	21
40	7 54 40	4 5 20	9.70761	9.93457	9.77303	10.22697	10.06543	10.29239	20
41	54 32	5 28	70782	93450	77332	22668	06550	29218	19
42	54 24	5 36	70803	93442	77361	22639	06558	29197	18
43	54 16	5 44	70824	93435	77390	22610	06565	29176	17
44	54 8	5 52	70846	93427	77418	22582	06573	29154	16
45	7 54 0	4 6 0	9.70867	9.93420	9.77447	10.22553	10.06580	10.29133	15
46	53 52	6 8	70888	93412	77476	22524	06588	29112	14
47	53 44	6 16	70909	93405	77505	22495	06595	29091	13
48	53 36	6 24	70931	93397	77533	22467	06603	29069	12
49	53 28	6 32	70952	93390	77562	22438	06610	29048	11
50	7 53 20	4 6 40	9.70973	9.93382	9.77591	10.22409	10.06618	10.29027	10
51	53 12	6 48	70994	93375	77619	22381	06625	29006	9
52	53 4	6 56	71015	93367	77648	22352	06633	28985	8
53	52 56	7 4	71036	93360	77677	22323	06640	28964	7
54	52 48	7 12	71058	93352	77706	22294	06648	28942	6
55	7 52 40	4 7 20	9.71079	9.93344	9.77734	10.22266	10.06656	10.28921	5
56	52 32	7 28	71100	93337	77763	22237	06663	28900	4
57	52 24	7 36	71121	93329	77791	22209	06671	28879	3
58	52 16	7 44	71142	93322	77820	22180	06678	28858	2
59	52 8	7 52	71163	93314	77849	22151	06686	28837	1
60	52 0	8 0	71184	93307	77877	22123	06693	28816	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

120 Degs. Degs. 59

Log. Sines, Tangents and Secants.

31 Degs. Deg. 148.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 52 0	4 8 0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
1	51 52	8 8	71205	93299	77906	22094	06701	28795	59
2	51 44	8 16	71226	93291	77935	22065	06709	28774	58
3	51 36	8 24	71247	93284	77963	22037	06716	28753	57
4	51 28	8 32	71268	93276	77992	22008	06724	28732	56
5	7 51 20	4 8 40	9.71289	9.93269	9.78020	10.21980	10.06731	10.28711	55
6	51 12	8 48	71310	93261	78049	21951	06739	28690	54
7	51 4	8 56	71331	93253	78077	21923	06747	28669	53
8	50 56	9 4	71352	93246	78106	21894	06754	28648	52
9	50 48	9 12	71373	93238	78135	21865	06762	28627	51
10	7 50 40	4 9 20	9.71393	9.93230	9.78163	10.21837	10.06770	10.28607	50
11	50 32	9 28	71414	93223	78192	21808	06777	28586	49
12	50 24	9 36	71435	93215	78220	21780	06785	28565	48
13	50 16	9 44	71456	93207	78249	21751	06793	28544	47
14	50 8	9 52	71477	93200	78277	21723	06800	28523	46
15	7 50 0	4 10 0	9.71498	9.93192	9.78306	10.21694	10.06808	10.28502	45
16	49 52	10 8	71519	93184	78334	21666	06816	28481	44
17	49 44	10 16	71539	93177	78363	21637	06823	28461	43
18	49 36	10 24	71560	93169	78391	21609	06831	28440	42
19	49 28	10 32	71581	93161	78419	21581	06839	28419	41
20	7 49 20	4 10 40	9.71602	9.93154	9.78448	10.21552	10.06846	10.28398	40
21	49 12	10 48	71622	93146	78476	21524	06854	28378	39
22	49 4	10 56	71643	93138	78505	21495	06862	28357	38
23	48 56	11 4	71664	93131	78533	21467	06869	28336	37
24	48 48	11 12	71685	93123	78562	21438	06877	28315	36
25	7 48 40	4 11 20	9.71705	9.93115	9.78590	10.21410	10.06885	10.28295	35
26	48 32	11 28	71726	93108	78618	21382	06892	28274	34
27	48 24	11 36	71747	93100	78647	21353	06900	28253	33
28	48 16	11 44	71767	93092	78675	21325	06908	28233	32
29	48 8	11 52	71788	93084	78704	21296	06916	28212	31
30	7 48 0	4 12 0	9.71809	9.93077	9.78732	10.21268	10.06923	10.28191	30
31	47 52	12 8	71829	93069	78760	21240	06931	28171	29
32	47 44	12 16	71850	93061	78789	21211	06939	28150	28
33	47 36	12 24	71870	93053	78817	21183	06947	28130	27
34	47 28	12 32	71891	93046	78845	21155	06954	28109	26
35	7 47 20	4 12 40	9.71911	9.93038	9.78874	10.21126	10.06962	10.28089	25
36	47 12	12 48	71932	93030	78902	21098	06970	28068	24
37	47 4	12 56	71952	93022	78930	21070	06978	28048	23
38	46 56	13 4	71973	93014	78959	21041	06986	28027	22
39	46 48	13 12	71994	93007	78987	21013	06993	28006	21
40	7 46 40	4 13 20	9.72014	9.92999	9.79015	10.20985	10.07001	10.27986	20
41	46 32	13 28	72034	92991	79043	20957	07009	27966	19
42	46 24	13 36	72055	92983	79072	20928	07017	27945	18
43	46 16	13 44	72075	92976	79100	20900	07024	27925	17
44	46 8	13 52	72096	92968	79128	20872	07032	27904	16
45	7 46 0	4 14 0	9.72116	9.92960	9.79156	10.20844	10.07040	10.27884	15
46	45 52	14 8	72137	92952	79185	20815	07048	27863	14
47	45 44	14 16	72157	92944	79213	20787	07056	27843	13
48	45 36	14 24	72177	92936	79241	20759	07064	27823	12
49	45 28	14 32	72198	92929	79269	20731	07071	27802	11
50	7 45 20	4 14 40	9.72218	9.92921	9.79297	10.20703	10.07079	10.27782	10
51	45 12	14 48	72238	92913	79326	20674	07087	27762	9
52	45 4	14 56	72259	92905	79354	20646	07095	27741	8
53	44 56	15 4	72279	92897	79382	20618	07103	27721	7
54	44 48	15 12	72299	92889	79410	20590	07111	27701	6
55	7 44 40	4 15 20	9.72320	9.92881	9.79438	10.20562	10.07119	10.27680	5
56	44 32	15 28	72340	92874	79466	20534	07126	27660	4
57	44 24	15 36	72360	92866	79495	20505	07134	27640	3
58	44 16	15 44	72381	92858	79523	20477	07142	27619	2
59	44 8	15 52	72401	92850	79551	20449	07150	27599	1
60	44 0	16 0	72421	92842	79579	20421	07158	27579	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

121 Degs. Degs. 58.

TABLE XXVII.

Log. Sines, Tangents and Secants.

32 Degs. Degs. 147.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 44 0	4 16 0	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	60
1	43 52	16 8	72441	92834	79607	20393	07166	27559	59
2	43 44	16 16	72461	92826	79635	20365	07174	27539	58
3	43 36	16 24	72482	92818	79663	20337	07182	27518	57
4	43 28	16 32	72502	92810	79691	20309	07190	27498	56
5	7 43 20	4 16 40	9.72522	9.92803	9.79719	10.20281	10.07197	10.27478	55
6	43 12	16 48	72542	92795	79747	20253	07205	27458	54
7	43 4	16 56	72562	92787	79776	20224	07213	27438	53
8	42 56	17 4	72582	92779	79804	20196	07221	27418	52
9	42 48	17 12	72602	92771	79832	20168	07229	27398	51
10	7 42 40	4 17 20	9.72622	9.92763	9.79860	10.20140	10.07237	10.27378	50
11	42 32	17 28	72643	92755	79888	20112	07245	27357	49
12	42 24	17 36	72663	92747	79916	20084	07253	27337	48
13	42 16	17 44	72683	92739	79944	20056	07261	27317	47
14	42 8	17 52	72703	92731	79972	20028	07269	27297	46
15	7 42 0	4 18 0	9.72723	9.92723	9.80000	10.20000	10.07277	10.27277	45
16	41 52	18 8	72743	92715	80028	19972	07285	27257	44
17	41 44	18 16	72763	92707	80056	19944	07293	27237	43
18	41 36	18 24	72783	92699	80084	19916	07301	27217	42
19	41 28	18 32	72803	92691	80112	19888	07309	27197	41
20	7 41 20	4 18 40	9.72823	9.92683	9.80140	10.19860	10.07317	10.27177	40
21	41 12	18 48	72843	92675	80168	19832	07325	27157	39
22	41 4	18 56	72863	92667	80195	19805	07333	27137	38
23	40 56	19 4	72883	92659	80223	19777	07341	27117	37
24	40 48	19 12	72902	92651	80251	19749	07349	27098	36
25	7 40 40	4 19 20	9.72922	9.92643	9.80279	10.19721	10.07357	10.27078	35
26	40 32	19 28	72942	92635	80307	19693	07365	27058	34
27	40 24	19 36	72962	92627	80335	19665	07373	27038	33
28	40 16	19 44	72982	92619	80363	19637	07381	27018	32
29	40 8	19 52	73002	92611	80391	19609	07389	26998	31
30	7 40 0	4 20 0	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
31	39 52	20 8	73041	92595	80447	19553	07405	26959	29
32	39 44	20 16	73061	92587	80474	19526	07413	26939	28
33	39 36	20 24	73081	92579	80502	19498	07421	26919	27
34	39 28	20 32	73101	92571	80530	19470	07429	26899	26
35	7 39 20	4 20 40	9.73121	9.92563	9.80558	10.19442	10.07437	10.26879	25
36	39 12	20 48	73140	92555	80586	19414	07445	26860	24
37	39 4	20 56	73160	92546	80614	19386	07454	26840	23
38	38 56	21 4	73180	92538	80642	19358	07462	26820	22
39	38 48	21 12	73200	92530	80669	19331	07470	26800	21
40	7 38 40	4 21 20	9.73219	9.92522	9.80697	10.19303	10.07478	10.26781	20
41	38 32	21 28	73239	92514	80725	19275	07486	26761	19
42	38 24	21 36	73259	92506	80753	19247	07494	26741	18
43	38 16	21 44	73278	92498	80781	19219	07502	26722	17
44	38 8	21 52	73298	92490	80808	19192	07510	26702	16
45	7 38 0	4 22 0	9.73318	9.92482	9.80836	10.19164	10.07518	10.26682	15
46	37 52	22 8	73337	92473	80864	19136	07527	26663	14
47	37 44	22 16	73357	92465	80892	19108	07535	26643	13
48	37 36	22 24	73377	92457	80919	19081	07543	26623	12
49	37 28	22 32	73396	92449	80947	19053	07551	26604	11
50	7 37 20	4 22 40	9.73416	9.92441	9.80975	10.19025	10.07559	10.26584	10
51	37 12	22 48	73435	92433	81003	18997	07567	26565	9
52	37 4	22 56	73455	92425	81030	18970	07575	26545	8
53	36 56	23 4	73474	92416	81058	18942	07584	26526	7
54	36 48	23 12	73494	92408	81086	18914	07592	26506	6
55	7 36 40	4 23 20	9.73513	9.92400	9.81113	10.18887	10.07600	10.26487	5
56	36 32	23 28	73533	92392	81141	18859	07608	26467	4
57	36 24	23 36	73552	92384	81169	18831	07616	26448	3
58	36 16	23 44	73572	92376	81196	18804	07624	26428	2
59	36 8	23 52	73591	92367	81224	18776	07633	26409	1
60	36 0	24 0	73611	92359	81252	18748	07641	26389	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

122 Degs. Degs. 57.

Log. Sines, Tangents and Secants.

33 Degs. Degs. 146.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 36 0	4 24 0	9.73611	9.92359	9.81252	10.18748	10.07641	10.26389	60
1	35 52	24 8	73630	92351	81279	18721	07649	26370	59
2	35 44	24 16	73650	92343	81307	18693	07657	26350	58
3	35 36	24 24	73669	92335	81335	18665	07665	26331	57
4	35 28	24 32	73689	92326	81362	18638	07674	26311	56
5	7 35 20	4 24 40	9.73708	9.92318	9.81390	10.18610	10.07682	10.26292	55
6	35 12	24 48	73727	92310	81418	18582	07690	26273	54
7	35 4	24 56	73747	92302	81445	18555	07698	26253	53
8	34 56	25 4	73766	92293	81473	18527	07707	26234	52
9	34 48	25 12	73785	92285	81500	18500	07715	26215	51
10	7 34 40	4 25 20	9.73305	9.92277	9.81528	10.18472	10.07723	10.26195	50
11	34 32	25 28	73824	92269	81556	18444	07731	26176	49
12	34 24	25 36	73843	92260	81583	18417	07740	26157	48
13	34 16	25 44	73863	92252	81611	18389	07748	26137	47
14	34 8	25 52	73882	92244	81638	18362	07756	26118	46
15	7 34 0	4 26 0	9.73901	9.92235	9.81666	10.18334	10.07765	10.26099	45
16	33 52	26 8	73921	92227	81693	18307	07773	26079	44
17	33 44	26 16	73940	92219	81721	18279	07781	26060	43
18	33 36	26 24	73959	92211	81748	18252	07789	26041	42
19	33 28	26 32	73978	92202	81776	18224	07798	26022	41
20	7 33 20	4 26 40	9.73997	9.92194	9.81803	10.18197	10.07806	10.26003	40
21	33 12	26 43	74017	92186	81831	18169	07814	25983	39
22	33 4	26 56	74036	92177	81858	18142	07823	25964	38
23	32 56	27 4	74055	92169	81886	18114	07831	25945	37
24	32 48	27 12	74074	92161	81913	18087	07839	25926	36
25	7 32 40	4 27 20	9.74693	9.92152	9.81941	10.18059	10.07848	10.25907	35
26	32 32	27 28	74113	92144	81968	18032	07856	25887	34
27	32 24	27 36	74132	92136	81996	18004	07864	25868	33
28	32 16	27 44	74151	92127	82023	17977	07873	25849	32
29	32 8	27 52	74170	92119	82051	17949	07881	25830	31
30	7 32 0	4 28 0	9.74189	9.92111	9.82078	10.17922	10.07889	10.25811	30
31	31 52	28 8	74208	92102	82106	17894	07898	25792	29
32	31 44	28 16	74227	92094	82133	17867	07906	25773	28
33	31 36	28 24	74246	92086	82161	17839	07914	25754	27
34	31 28	28 32	74265	92077	82188	17812	07923	25735	26
35	7 31 20	4 28 40	9.74284	9.92069	9.82215	10.17785	10.07931	10.25716	25
36	31 12	28 48	74303	92060	82243	17757	07940	25697	24
37	31 4	28 56	74322	92052	82270	17730	07948	25678	23
38	30 56	29 4	74341	92044	82298	17702	07956	25659	22
39	30 43	29 12	74360	92035	82325	17675	07965	25640	21
40	7 30 40	4 29 20	9.74379	9.92027	9.82352	10.17648	10.07973	10.25621	20
41	30 32	29 28	74398	92018	82380	17620	07982	25602	19
42	30 24	29 36	74417	92010	82407	17593	07990	25583	18
43	30 16	29 44	74436	92002	82435	17565	07998	25564	17
44	30 8	29 52	74455	91993	82462	17538	08007	25545	16
45	7 30 0	4 30 0	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	15
46	29 52	30 8	74493	91976	82517	17483	08024	25607	14
47	29 44	30 16	74512	91968	82544	17456	08032	25488	13
48	29 36	30 24	74531	91959	82571	17429	08041	25469	12
49	29 28	30 32	74549	91951	82599	17401	08049	25451	11
50	7 29 20	4 30 40	9.74568	9.91942	9.82626	10.17374	10.08058	10.25432	10
51	29 12	30 43	74587	91934	82653	17347	08066	25413	9
52	29 4	30 56	74606	91925	82681	17319	08075	25394	8
53	28 56	31 4	74625	91917	82708	17292	08083	25375	7
54	28 48	31 12	74644	91908	82735	17265	08092	25356	6
55	7 28 40	4 31 20	9.74662	9.91900	9.82762	10.17238	10.08100	10.25338	5
56	28 32	31 28	74681	91891	82790	17210	08109	25319	4
57	28 24	31 36	74700	91883	82817	17183	08117	25300	3
58	28 16	31 44	74719	91874	82844	17156	08126	25281	2
59	28 8	31 52	74737	91366	82871	17129	08134	25263	1
60	28 0	32 0	74756	91857	32899	17101	08143	25244	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

TABLE XXVII.

Log. Sines, Tangents and Secants.

34 Degs. Degs. 145.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 28 0	4 32 0	9.74756	9.91857	9.82899	10.17101	10.08143	10.25244	60
1	27 52	32 8	74775	91849	82926	17074	08151	25225	59
2	27 44	32 16	74794	91840	82953	17047	08160	25206	58
3	27 36	32 24	74812	91832	82980	17020	08168	25188	57
4	27 28	32 32	74831	91823	83008	16992	08177	25169	56
5	7 27 20	4 32 40	9.74850	9.91815	9.83035	10.16965	10.08185	10.25150	55
6	27 12	32 48	74868	91806	83062	16938	08194	25132	54
7	27 4	32 56	74887	91798	83089	16911	08202	25113	53
8	26 56	33 4	74906	91789	83117	16883	08211	25094	52
9	26 48	33 12	74924	91781	83144	16856	08219	25076	51
10	7 26 40	4 33 20	9.74943	9.91772	9.83171	10.16829	10.08228	10.25057	50
11	26 32	33 28	74961	91763	83198	16802	08237	25039	49
12	26 24	33 36	74980	91755	83225	16775	08245	25020	48
13	26 16	33 44	74999	91746	83252	16748	08254	25001	47
14	26 8	33 52	75017	91738	83280	16720	08262	24983	46
15	7 26 0	4 34 0	9.75036	9.91729	9.83307	10.16693	10.08271	10.24964	45
16	25 52	34 8	75054	91720	83334	16666	08280	24946	44
17	25 44	34 16	75073	91712	83361	16639	08288	24927	43
18	25 36	34 24	75091	91703	83388	16612	08297	24909	42
19	25 28	34 32	75110	91695	83415	16585	08305	24890	41
20	7 25 20	4 34 40	9.75128	9.91686	9.83442	10.16558	10.08314	10.24872	40
21	25 12	34 48	75147	91677	83470	16530	08323	24853	39
22	25 4	34 56	75165	91669	83497	16503	08331	24835	38
23	24 56	35 4	75184	91660	83524	16476	08340	24816	37
24	24 48	35 12	75202	91651	83551	16449	08349	24798	36
25	7 24 40	4 35 20	9.75221	9.91643	9.83578	10.16422	10.08357	10.24779	35
26	24 32	35 28	75239	91634	83605	16395	08366	24761	34
27	24 24	35 36	75258	91625	83632	16368	08375	24742	33
28	24 16	35 44	75276	91617	83659	16341	08383	24724	32
29	24 8	35 52	75294	91608	83686	16314	08392	24706	31
30	7 24 0	4 36 0	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
31	23 52	36 8	75331	91591	83740	16260	08409	24669	29
32	23 44	36 16	75350	91582	83768	16232	08418	24650	28
33	23 36	36 24	75368	91573	83795	16205	08427	24632	27
34	23 28	36 32	75386	91565	83822	16178	08435	24614	26
35	7 23 20	4 36 40	9.75405	9.91556	9.83849	10.16151	10.08444	10.24595	25
36	23 12	36 48	75423	91547	83876	16124	08453	24577	24
37	23 4	36 56	75441	91538	83903	16097	08462	24559	23
38	22 56	37 4	75459	91530	83930	16070	08470	24541	22
39	22 48	37 12	75478	91521	83957	16043	08479	24522	21
40	7 22 40	4 37 20	9.75496	9.91512	9.83984	10.16016	10.08488	10.24504	20
41	22 32	37 28	75514	91504	84011	15989	08496	24486	19
42	22 24	37 36	75533	91495	84038	15962	08505	24467	18
43	22 16	37 44	75551	91486	84065	15935	08514	24449	17
44	22 8	37 52	75569	91477	84092	15908	08523	24431	16
45	7 22 0	4 38 0	9.75587	9.91469	9.84119	10.15881	10.08531	10.24413	15
46	21 52	38 8	75605	91460	84146	15854	08540	24395	14
47	21 44	38 16	75624	91451	84173	15827	08549	24376	13
48	21 36	38 24	75642	91442	84200	15800	08558	24358	12
49	21 28	38 32	75660	91433	84227	15773	08567	24340	11
50	7 21 20	4 38 40	9.75678	9.91425	9.84254	10.15746	10.08575	10.24322	10
51	21 12	38 48	75696	91416	84280	15720	08584	24304	9
52	21 4	38 56	75714	91407	84307	15693	08593	24286	8
53	20 56	39 4	75733	91398	84334	15666	08602	24267	7
54	20 48	39 12	75751	91389	84361	15639	08611	24249	6
55	7 20 40	4 39 20	9.75769	9.91381	9.84388	10.15612	10.08619	10.24231	5
56	20 32	39 28	75787	91372	84415	15585	08628	24213	4
57	20 24	39 36	75805	91363	84442	15558	08637	24195	3
58	20 16	39 44	75823	91354	84469	15531	08646	24177	2
59	20 8	39 52	75841	91345	84496	15504	08655	24159	1
60	20 0	40 0	75859	91336	84523	15477	08664	24141	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

124 Degs. Degs. 55.

TABLE XXVII.

Log. Sines, Tangents and Secants.

35 Degs. Degs. 144.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 20 0	4 40 0	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	60
1	19 52	40 8	75877	91328	84550	15450	08672	24123	59
2	19 44	40 16	75895	91319	84576	15424	08681	24105	58
3	19 36	40 24	75913	91310	84603	15397	08690	24087	57
4	19 28	40 32	75931	91301	84630	15370	08699	24069	56
5	7 19 20	4 40 40	9.75949	9.91292	9.84657	10.15343	10.08708	10.24051	55
6	19 12	40 48	75967	91283	84684	15316	08717	24033	54
7	19 4	40 56	75985	91274	84711	15289	08726	24015	53
8	18 56	41 4	76003	91266	84738	15262	08734	23997	52
9	18 48	41 12	76021	91257	84764	15236	08743	23979	51
10	7 18 40	4 41 20	9.76039	9.91248	9.84791	10.15209	10.08752	10.23961	50
11	18 32	41 28	76057	91239	84818	15182	08761	23943	49
12	18 24	41 36	76075	91230	84845	15155	08770	23925	48
13	18 16	41 44	76093	91221	84872	15128	08779	23907	47
14	18 8	41 52	76111	91212	84899	15101	08788	23889	46
15	7 18 0	4 42 0	9.76129	9.91203	9.84925	10.15075	10.08797	10.23871	45
16	17 52	42 8	76146	91194	84952	15048	08806	23854	44
17	17 44	42 16	76164	91185	84979	15021	08815	23836	43
18	17 36	42 24	76182	91176	85006	14994	08824	23818	42
19	17 28	42 32	76200	91167	85033	14967	08833	23800	41
20	7 17 20	4 42 40	9.76218	9.91158	9.85059	10.14941	10.08842	10.23782	40
21	17 12	42 48	76236	91149	85086	14914	08851	23764	39
22	17 4	42 56	76253	91141	85113	14887	08859	23747	38
23	16 56	43 4	76271	91132	85140	14860	08868	23729	37
24	16 48	43 12	76289	91123	85166	14834	08877	23711	36
25	7 16 40	4 43 20	9.76307	9.91114	9.85193	10.14807	10.08886	10.23693	35
26	16 32	48 28	76324	91105	85220	14780	08895	23676	34
27	16 24	43 36	76342	91096	85247	14753	08904	23658	33
28	16 16	43 44	76360	91087	85273	14727	08913	23640	32
29	16 8	43 52	76378	91078	85300	14700	08922	23622	31
30	7 16 0	4 44 0	9.76395	9.91069	9.85327	10.14673	10.08931	10.23605	30
31	15 52	44 8	76413	91060	85354	14646	08940	23587	29
32	15 44	44 16	76431	91051	85380	14620	08949	23569	28
33	15 36	44 24	76448	91042	85407	14593	08958	23552	27
34	15 28	44 32	76466	91033	85434	14566	08967	23534	26
35	7 15 20	4 44 40	9.76484	9.91023	9.85460	10.14540	10.08977	10.23516	25
36	15 12	44 48	76501	91014	85487	14513	08986	23499	24
37	15 4	44 56	76519	91005	85514	14486	08995	23481	23
38	14 56	45 4	76537	90996	85540	14460	09004	23463	22
39	14 48	45 12	76554	90987	85567	14433	09013	23446	21
40	7 14 40	4 45 20	9.76572	9.90978	9.85594	10.14406	10.09022	10.23428	20
41	14 32	45 28	76590	90969	85620	14380	09031	23410	19
42	14 24	45 36	76607	90960	85647	14353	09040	23393	18
43	14 16	45 44	76625	90951	85674	14326	09049	23375	17
44	14 8	45 52	76642	90942	85700	14300	09058	23358	16
45	7 14 0	4 46 0	9.76660	9.90933	9.85727	10.14273	10.09067	10.23340	15
46	13 52	46 8	76677	90924	85754	14246	09076	23323	14
47	13 44	46 16	76695	90915	85780	14220	09085	23305	13
48	13 36	46 24	76712	90906	85807	14193	09094	23288	12
49	13 28	46 32	76730	90896	85834	14166	09104	23270	11
50	7 13 20	4 46 40	9.76747	9.90887	9.85860	10.14140	10.09113	10.23253	10
51	13 12	46 48	76765	90878	85887	14113	09122	23235	9
52	13 4	46 56	76782	90869	85913	14087	09131	23218	8
53	12 56	47 4	76800	90860	85940	14060	09140	23200	7
54	12 48	47 12	76317	90851	85967	14033	09149	23183	6
55	7 12 40	4 47 20	9.76835	9.90842	9.85993	10.14007	10.09158	10.23165	5
56	12 32	47 28	76852	90832	86020	13980	09168	23148	4
57	12 24	47 36	76870	90823	86046	13954	09177	23130	3
58	12 16	47 44	76887	90814	86073	13927	09186	23113	2
59	12 8	47 52	76904	90805	86100	13900	09195	23096	1
60	12 0	48 0	76922	90796	86126	13874	09204	23078	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

125 Degs. Degs. 54.

TABLE XXVII.

Log. Sines, Tangents and Secants.

36 Degs. Degs. 143.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	7 12 0	4 48 0	9.76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
1	11 52	48 8	76939	90787	86153	13847	09213	23061	59
2	11 44	48 16	76957	90777	86179	13821	09223	23043	58
3	11 36	48 24	76974	90768	86206	13794	09232	23026	57
4	11 28	48 32	76991	90759	86232	13768	09241	23009	56
5	7 11 20	4 48 40	9.77009	9.90750	9.86259	10.13741	10.09250	10.22991	55
6	11 12	48 48	77026	90741	86285	13715	09259	22974	54
7	11 4	48 56	77043	90731	86312	13688	09269	22957	53
8	10 56	49 4	77061	90722	86338	13662	09278	22939	52
9	10 48	49 12	77078	90713	86365	13635	09287	22922	51
10	7 10 40	4 49 20	9.77095	9.90704	9.86392	10.13608	10.09296	10.22905	50
11	10 32	49 28	77112	90694	86418	13582	09306	22888	49
12	10 24	49 36	77130	90685	86445	13555	09315	22870	48
13	10 16	49 44	77147	90676	86471	13529	09324	22853	47
14	10 8	49 52	77164	90667	86498	13502	09333	22836	46
15	7 10 0	4 50 0	9.77181	9.90657	9.86524	10.13476	10.09343	10.22819	45
16	9 52	50 8	77199	90648	86551	13449	09352	22801	44
17	9 44	50 16	77216	90639	86577	13423	09361	22784	43
18	9 36	50 24	77233	90630	86603	13397	09370	22767	42
19	9 28	50 32	77250	90620	86630	13370	09380	22750	41
20	7 9 20	4 50 40	9.77268	9.90611	9.86656	10.13344	10.09389	10.22732	40
21	9 12	50 48	77285	90602	86683	13317	09398	22715	39
22	9 4	50 56	77302	90592	86709	13291	09408	22698	38
23	8 56	51 4	77319	90583	86736	13264	09417	22631	37
24	8 48	51 12	77336	90574	86762	13238	09426	22664	36
25	7 8 40	4 51 20	9.77353	9.90565	9.86789	10.13211	10.09435	10.22647	35
26	8 32	51 28	77370	90555	86815	13185	09445	22630	34
27	8 24	51 36	77387	90546	86842	13158	09454	22613	33
28	8 16	51 44	77405	90537	86868	13132	09463	22595	32
29	8 8	51 52	77422	90527	86894	13106	09473	22578	31
30	7 8 0	4 52 0	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
31	7 52	52 8	77456	90509	86947	13053	09491	22544	29
32	7 44	52 16	77473	90499	86974	13026	09501	22527	28
33	7 36	52 24	77490	90490	87000	13000	09510	22510	27
34	7 28	52 32	77507	90480	87027	12973	09520	22493	26
35	7 7 20	4 52 40	9.77524	9.90471	9.87053	10.12947	10.09529	10.22476	25
36	7 12	52 48	77541	90462	87079	12921	09538	22459	24
37	7 4	52 56	77558	90452	87106	12894	09548	22442	23
38	6 56	53 4	77575	90443	87132	12868	09557	22425	22
39	6 48	53 12	77592	90434	87158	12842	09566	22408	21
40	7 6 40	4 53 20	9.77609	9.90424	9.87185	10.12815	10.09576	10.22391	20
41	6 32	53 28	77626	90415	87211	12789	09585	22374	19
42	6 24	53 36	77643	90405	87238	12762	09595	22357	18
43	6 16	53 44	77660	90396	87264	12736	09604	22340	17
44	6 8	53 52	77677	90386	87290	12710	09614	22323	16
45	7 6 0	4 54 0	9.77694	9.90377	9.87317	10.12683	10.09623	10.22306	15
46	5 52	54 8	77711	90368	87343	12657	09632	22289	14
47	5 44	54 16	77728	90358	87369	12631	09642	22272	13
48	5 36	54 24	77744	90349	87396	12604	09651	22256	12
49	5 28	54 32	77761	90339	87422	12578	09661	22239	11
50	7 5 20	4 54 40	9.77778	9.90330	9.87448	10.12552	10.09670	10.22222	10
51	5 12	54 48	77795	90320	87475	12525	09680	22205	9
52	5 4	54 56	77812	90311	87501	12499	09689	22188	8
53	4 56	55 4	77829	90301	87527	12473	09699	22171	7
54	4 48	55 12	77846	90292	87554	12446	09708	22154	6
55	7 4 40	4 55 20	9.77862	9.90282	9.87580	10.12420	10.09718	10.22138	5
56	4 32	55 28	77879	90273	87606	12394	09727	22121	4
57	4 24	55 36	77896	90263	87633	12367	09737	22104	3
58	4 16	55 44	77913	90254	87659	12341	09746	22087	2
59	4 8	55 52	77930	90244	87685	12315	09756	22070	1
60	4 0	56 0	77946	90235	87711	12289	09765	22054	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

126 Degs. Degs. 53.

TABLE XXVII.

Log. Sines, Tangents and Secants.

37 Degs. Degs. 142.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	7 4 0	4 56 0	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	60
1	3 52	56 8	77963	90225	87738	12262	09775	22037	59
2	3 44	56 16	77980	90216	87764	12236	09784	22020	58
3	3 36	56 24	77997	90206	87790	12210	09794	22003	57
4	3 28	56 32	78013	90197	87817	12183	09803	21987	56
5	7 3 20	4 56 40	9.78030	9.90187	9.87843	10.12157	10.09813	10.21970	55
6	3 12	56 48	78047	90178	87869	12131	09822	21953	54
7	3 4	56 56	78063	90168	87895	12105	09832	21937	53
8	2 56	57 4	78080	90159	87922	12078	09841	21920	52
9	2 48	57 12	78097	90149	87948	12052	09851	21903	51
10	7 2 40	4 57 20	9.78113	9.90139	9.87974	10.12026	10.09861	10.21887	50
11	2 32	57 28	78130	90130	88000	12000	09870	21870	49
12	2 24	57 36	78147	90120	88027	11973	09880	21853	48
13	2 16	57 44	78163	90111	88053	11947	09889	21837	47
14	2 8	57 52	78180	90101	88079	11921	09899	21820	46
15	7 2 0	4 58 0	9.78197	9.90091	9.88105	10.11895	10.09909	10.21803	45
16	1 52	58 8	78213	90082	88131	11869	09918	21787	44
17	1 44	58 16	78230	90072	88158	11842	09928	21770	43
18	1 36	58 24	78246	90063	88184	11816	09937	21754	42
19	1 28	58 32	78263	90053	88210	11790	09947	21737	41
20	7 1 20	4 58 40	9.78280	9.90043	9.88236	10.11764	10.09957	10.21720	40
21	1 12	58 48	78296	90034	88262	11738	09966	21704	39
22	1 4	58 56	78313	90024	88289	11711	09976	21687	38
23	0 56	59 4	78329	90014	88315	11685	09986	21671	37
24	0 48	59 12	78346	90005	88341	11659	09995	21654	36
25	7 0 40	4 59 20	9.78362	9.89995	9.88367	10.11633	10.10005	10.21638	35
26	0 32	59 28	78379	89985	88393	11607	10015	21621	34
27	0 24	59 36	78395	89976	88420	11580	10024	21605	33
28	0 16	59 44	78412	89966	88446	11554	10034	21588	32
29	0 8	59 52	78428	89956	88472	11528	10044	21572	31
30	7 0 0	5 0 0	9.78445	9.89947	9.88498	10.11502	10.10053	10.21555	30
31	6 59 52	0 8	78461	89937	88524	11476	10063	21539	29
32	59 44	0 16	78478	89927	88550	11450	10073	21522	28
33	59 36	0 24	78494	89918	88577	11423	10082	21506	27
34	59 28	0 32	78510	89908	88603	11397	10092	21490	26
35	6 59 20	5 0 40	9.78527	9.89898	9.88629	10.11371	10.10102	10.21473	25
36	59 12	0 48	78543	89888	88655	11345	10112	21457	24
37	59 4	0 56	78560	89879	88681	11319	10121	21440	23
38	58 56	1 4	78576	89869	88707	11293	10131	21424	22
39	58 48	1 12	78592	89859	88733	11267	10141	21408	21
40	6 58 40	5 1 20	9.78609	9.89849	9.88759	10.11241	10.10151	10.21391	20
41	58 32	1 28	78625	89840	88786	11214	10160	21375	19
42	58 24	1 36	78642	89830	88812	11188	10170	21358	18
43	58 16	1 44	78658	89820	88838	11162	10180	21342	17
44	58 8	1 52	78674	89810	88864	11136	10190	21326	16
45	6 58 0	5 2 0	9.78691	9.89801	9.88890	10.11110	10.10199	10.21309	15
46	57 52	2 8	78707	89791	88916	11084	10209	21293	14
47	57 44	2 16	78723	89781	88942	11058	10219	21277	13
48	57 36	2 24	78739	89771	88968	11032	10229	21261	12
49	57 28	2 32	78756	89761	88994	11006	10239	21244	11
50	6 57 20	5 2 40	9.78772	9.89752	9.89020	10.10980	10.10248	10.21228	10
51	57 12	2 48	78788	89742	89046	10954	10258	21212	9
52	57 4	2 56	78805	89732	89073	10927	10268	21195	8
53	56 56	3 4	78821	89722	89099	10901	10278	21179	7
54	56 48	3 12	78837	89712	89125	10875	10288	21163	6
55	6 56 40	5 3 20	9.78853	9.89702	9.89151	10.10849	10.10298	10.21147	5
56	56 32	3 28	78869	89693	89177	10823	10307	21131	4
57	56 24	3 36	78886	89683	89203	10797	10317	21114	3
58	56 16	3 44	78902	89673	89229	10771	10327	21098	2
59	56 8	3 52	78918	89663	89255	10745	10337	21082	1
60	56 0	4 0	78934	89653	89281	10719	10347	21066	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

127 Degs. Degs. 52.

TABLE XXVII.

Log. Sines, Tangents and Secants.

38 Degs. | Degs. 141.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	6 56 0	5 4 0	9.78934	9.89653	9.89281	10.10719	10.10347	10.21066	60
1	55 52	4 8	78950	89643	89307	10693	10357	21050	59
2	55 44	4 16	78967	89633	89333	10667	10367	21033	58
3	55 36	4 24	78983	89624	89359	10641	10376	21017	57
4	55 28	4 32	78999	89614	89385	10615	10386	21001	56
5	6 55 20	5 4 40	9.79015	9.89604	9.89411	10.10589	10.10396	10.20985	55
6	55 12	4 48	79031	89594	89437	10563	10406	20969	54
7	55 4	4 56	79047	89584	89463	10537	10416	20953	53
8	54 56	5 4	79063	89574	89489	10511	10426	20937	52
9	54 48	5 12	79079	89564	89515	10485	10436	20921	51
10	6 54 40	5 5 20	9.79095	9.89554	9.89541	10.10459	10.10446	10.20905	50
11	54 32	5 28	79111	89544	89567	10433	10456	20889	49
12	54 24	5 36	79128	89534	89593	10407	10466	20872	48
13	54 16	5 44	79144	89524	89619	10381	10476	20856	47
14	54 8	5 52	79160	89514	89645	10355	10486	20840	46
15	6 54 0	5 6 0	9.79176	9.89504	9.89671	10.10329	10.10496	10.20824	45
16	53 52	6 8	79192	89495	89697	10303	10505	20808	44
17	53 44	6 16	79208	89485	89723	10277	10515	20792	43
18	53 36	6 24	79224	89475	89749	10251	10525	20776	42
19	53 28	6 32	79240	89465	89775	10225	10535	20760	41
20	6 53 20	5 6 40	9.79256	9.89455	9.89801	10.10199	10.10545	10.20744	40
21	53 12	6 48	79272	89445	89827	10173	10555	20728	39
22	53 4	6 56	79288	89435	89853	10147	10565	20712	38
23	52 56	7 4	79304	89425	89879	10121	10575	20696	37
24	52 48	7 12	79319	89415	89905	10095	10585	20681	36
25	6 52 40	5 7 20	9.79335	9.89405	9.89931	10.10069	10.10595	10.20665	35
26	52 32	7 28	79351	89395	89957	10043	10605	20649	34
27	52 24	7 36	79367	89385	89983	10017	10615	20633	33
28	52 16	7 44	79383	89375	90009	09991	10625	20617	32
29	52 8	7 52	79399	89364	90035	09965	10636	20601	31
30	6 52 0	5 8 0	9.79415	9.89354	9.90061	10.09939	10.10646	10.20585	30
31	51 52	8 8	79431	89344	90086	09914	10656	20569	29
32	51 44	8 16	79447	89334	90112	09888	10666	20553	28
33	51 36	8 24	79463	89324	90138	09862	10676	20537	27
34	51 28	8 32	79478	89314	90164	09836	10686	20522	26
35	6 51 20	5 8 40	9.79494	9.89304	9.90190	10.09810	10.10696	10.20506	25
36	51 12	8 48	79510	89294	90216	09784	10706	20490	24
37	51 4	8 56	79526	89284	90242	09758	10716	20474	23
38	50 56	9 4	79542	89274	90268	09732	10726	20458	22
39	50 43	9 12	79558	89264	90294	09706	10736	20442	21
40	6 50 40	5 9 20	9.79573	9.89254	9.90320	10.09680	10.10746	10.20427	20
41	50 32	9 28	79589	89244	90346	09654	10756	20411	19
42	50 24	9 36	79605	89233	90371	09629	10767	20395	18
43	50 16	9 44	79621	89223	90397	09603	10777	20379	17
44	50 8	9 52	79636	89213	90423	09577	10787	20364	16
45	6 50 0	5 10 0	9.79652	9.89203	9.90449	10.09551	10.10797	10.20348	15
46	49 52	10 8	79668	89193	90475	09525	10807	20332	14
47	49 44	10 16	79634	89183	90501	09499	10817	20316	13
48	49 36	10 24	79699	89173	90527	09473	10827	20301	12
49	49 28	10 32	79715	89162	90553	09447	10838	20285	11
50	6 49 20	5 10 40	9.79731	9.89152	9.90578	10.09422	10.10848	10.20269	10
51	49 12	10 48	79746	89142	90604	09396	10853	20254	9
52	49 4	10 56	79762	89132	90630	09370	10868	20238	8
53	48 56	11 4	79778	89122	90656	09344	10878	20222	7
54	48 48	11 12	79793	89112	90682	09318	10888	20207	6
55	6 48 40	5 11 20	9.79809	9.89101	9.90708	10.09292	10.10899	10.20191	5
56	48 32	11 23	79825	89091	90734	09266	10909	20175	4
57	48 24	11 36	79840	89081	90759	09241	10919	20160	3
58	48 16	11 44	79856	89071	90785	09215	10929	20144	2
59	48 8	11 52	79872	89060	90811	09189	10940	20128	1
60	48 0	12 0	79387	89050	90837	09163	10950	20113	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

128 Degs. | Degs. 51.

Log. Sines, Tangents and Secants.

39 Degs. Deg. 140.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	6 48 0	5 12 0	9.79887	9.89050	9.90837	10.09163	10.10950	10.20113	6
1	47 52	12 8	79903	89040	90863	09137	10960	20097	5
2	47 44	12 16	79918	89030	90889	09111	10970	20082	5
3	47 36	12 24	79934	89020	90914	09086	10980	20066	5
4	47 28	12 32	79950	89009	90940	09060	10991	20050	5
5	6 47 20	5 12 40	9.79965	9.88999	9.90966	10.09034	10.11001	10.20036	5
6	47 12	12 48	79981	88989	90992	09008	11011	20019	5
7	47 4	12 56	79996	88978	91018	08982	11022	20004	5
8	46 56	13 4	80012	88968	91043	08957	11032	19988	5
9	46 48	13 12	80027	88958	91069	08931	11042	19973	5
10	6 46 40	5 13 20	9.80043	9.88948	9.91095	10.08905	10.11052	10.19957	5
11	46 32	13 28	80058	88937	91121	08879	11063	19942	4
12	46 24	13 36	80074	88927	91147	08853	11073	19926	4
13	46 16	13 44	80089	88917	91172	08828	11083	19911	4
14	46 8	13 52	80105	88906	91198	08802	11094	19895	4
15	6 46 0	5 14 0	9.80120	9.88896	9.91224	10.08776	10.11104	10.19880	4
16	45 52	14 8	80136	88886	91250	08750	11114	19864	4
17	45 44	14 16	80151	88875	91276	08724	11125	19849	4
18	45 36	14 24	80166	88865	91301	08699	11135	19834	4
19	45 28	14 32	80182	88855	91327	08673	11145	19818	4
20	6 45 20	5 14 40	9.80197	9.88844	9.91353	10.08647	10.11156	10.19803	4
21	45 12	14 48	80213	88834	91379	08621	11166	19787	3
22	45 4	14 56	80228	88824	91404	08596	11176	19772	3
23	44 56	15 4	80244	88813	91430	08570	11187	19756	3
24	44 48	15 12	80259	88803	91456	08544	11197	19741	3
25	6 44 40	5 15 20	9.80274	9.88793	9.91482	10.08518	10.11207	10.19726	3
26	44 32	15 28	80290	88782	91507	08493	11218	19710	3
27	44 24	15 36	80305	88772	91533	08467	11228	19695	3
28	44 16	15 44	80320	88761	91559	08441	11239	19680	3
29	44 8	15 52	80336	88751	91585	08415	11249	19664	3
30	6 44 0	5 16 0	9.80351	9.88741	9.91610	10.08390	10.11259	10.19649	3
31	43 52	16 8	80366	88730	91636	08364	11270	19634	2
32	43 44	16 16	80382	88720	91662	08338	11280	19618	2
33	43 36	16 24	80397	88709	91688	08312	11291	19603	2
34	43 28	16 32	80412	88699	91713	08287	11301	19588	2
35	6 43 20	5 16 40	9.80428	9 88688	9.91739	10.08261	10.11312	10.19572	2
36	43 12	16 48	80443	88678	91765	08235	11322	19557	2
37	43 4	16 56	80458	88668	91791	08209	11332	19542	2
38	42 56	17 4	80473	88657	91816	08184	11343	19527	2
39	42 48	17 12	80489	88647	91842	08158	11353	19511	2
40	6 42 40	5 17 20	9.80504	9.88636	9.91868	10.08132	10.11364	10.19496	2
41	42 32	17 28	80519	88626	91893	08107	11374	19481	1
42	42 24	17 36	80534	88615	91919	08081	11385	19466	1
43	42 16	17 44	80550	88605	91945	08055	11395	19450	1
44	42 8	17 52	80565	88594	91971	08029	11406	19435	1
45	6 42 0	5 18 0	9.80580	9.88584	9.91996	10.08004	10.11416	10.19420	1
46	41 52	18 8	80595	88573	92022	07978	11427	19405	1
47	41 44	18 16	80610	88563	92048	07952	11437	19390	1
48	41 36	18 24	80625	88552	92073	07927	11448	19375	1
49	41 28	18 32	80641	88542	92099	07901	11458	19359	1
50	6 41 20	5 18 40	9.80656	9.88531	9.92125	10.07875	10.11469	10.19344	1
51	41 12	18 48	80671	88521	92150	07850	11479	19329	
52	41 4	18 56	80686	88510	92176	07824	11490	19314	
53	40 56	19 4	80701	88499	92202	07798	11501	19299	
54	40 48	19 12	80716	88489	92227	07773	11511	19284	
55	6 40 40	5 19 20	9.80731	9.88478	9.92253	10.07747	10.11522	10.19269	
56	40 32	19 28	80746	88468	92279	07721	11532	19254	
57	40 24	19 36	80762	88457	92304	07696	11543	19238	
58	40 16	19 44	80777	88447	92330	07670	11553	1922	
59	40 8	19 52	80792	88436	92356	07644	11564	192	
60	40 0	20 0	80807	88425	92381	07619	11575	19	
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Sec	

129 Degs.

TABLE XXVII.

Log. Sines, Tangents and Secants.

40 Degs. Degs. 139.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	6 40 0	5 20 0	9.80807	9.88425	9.92381	10.07619	10.11575	10.19193	60
1	39 52	20 8	80822	88415	92407	07593	11585	19178	59
2	39 44	20 16	80837	88404	92433	07567	11596	19163	58
3	39 36	20 24	80852	88394	92458	07542	11606	19148	57
4	39 28	20 32	80867	88383	92484	07516	11617	19133	56
5	6 39 20	5 20 40	9.80882	9.88372	9.92510	10.07490	10.11628	10.19118	55
6	39 12	20 48	80897	88362	92535	07465	11638	19103	54
7	39 4	20 56	80912	88351	92561	07439	11649	19088	53
8	38 56	21 4	80927	88340	92587	07413	11660	19073	52
9	38 48	21 12	80942	88330	92612	07388	11670	19058	51
10	6 38 40	5 21 20	9.80957	9.88319	9.92638	10.07362	10.11681	10.19043	50
11	38 32	21 28	80972	88308	92663	07337	11692	19028	49
12	38 24	21 36	80987	88298	92689	07311	11702	19013	48
13	38 16	21 44	81002	88287	92715	07285	11713	18998	47
14	38 8	21 52	81017	88276	92740	07260	11724	18983	46
15	6 38 0	5 22 0	9.81032	9.88266	9.92766	10.07234	10.11734	10.18968	45
16	37 52	22 8	81047	88255	92792	07208	11745	18953	44
17	37 44	22 16	81061	88244	92817	07183	11756	18939	43
18	37 36	22 24	81076	88234	92843	07157	11766	18924	42
19	37 28	22 32	81091	88223	92868	07132	11777	18909	41
20	6 37 20	5 22 40	9.81106	9.88212	9.92894	10.07106	10.11788	10.18894	40
21	37 12	22 48	81121	88201	92920	07080	11799	18879	39
22	37 4	22 56	81136	88191	92945	07055	11809	18864	38
23	36 56	23 4	81151	88180	92971	07029	11820	18849	37
24	36 48	23 12	81166	88169	92996	07004	11831	18834	36
25	6 36 40	5 23 20	9.81180	9.88158	9.93022	10.06978	10.11842	10.18820	35
26	36 32	23 28	81195	88148	93048	06952	11852	18805	34
27	36 24	23 36	81210	88137	93073	06927	11863	18790	33
28	36 16	23 44	81225	88126	93099	06901	11874	18775	32
29	36 8	23 52	81240	88115	93124	06876	11885	18760	31
30	6 36 0	5 24 0	9.81254	9.88105	9.93150	10.06850	10.11895	10.18746	30
31	35 52	24 8	81269	88094	93175	06825	11906	18731	29
32	35 44	24 16	81284	88083	93201	06799	11917	18716	28
33	35 36	24 24	81299	88072	93227	06773	11928	18701	27
34	35 28	24 32	81314	88061	93252	06748	11939	18686	26
35	6 35 20	5 24 40	9.81328	9.88051	9.93278	10.06722	10.11949	10.18672	25
36	35 12	24 48	81343	88040	93303	06697	11960	18657	24
37	35 4	24 56	81358	88029	93329	06671	11971	18642	23
38	34 56	25 4	81372	88018	93354	06646	11982	18628	22
39	34 48	25 12	81387	88007	93380	06620	11993	18613	21
40	6 34 40	5 25 20	9.81402	9.87996	9.93406	10.06594	10.12004	10.18598	20
41	34 32	25 28	81417	87985	93431	06569	12015	18583	19
42	34 24	25 36	81431	87975	93457	06543	12025	18569	18
43	34 16	25 44	81446	87964	93482	06518	12036	18554	17
44	34 8	25 52	81461	87953	93508	06492	12047	18539	16
45	6 34 0	5 26 0	9.81475	9.87942	9.93533	10.06467	10.12058	10.18525	15
46	33 52	26 8	81490	87931	93559	06441	12069	18510	14
47	33 44	26 16	81505	87920	93584	06416	12080	18495	13
48	33 36	26 24	81519	87909	93610	06390	12091	18481	12
49	33 28	26 32	81534	87898	93636	06364	12102	18466	11
50	6 33 20	5 26 40	9.81549	9.87887	9.93661	10.06339	10.12113	10.18451	10
51	33 12	26 48	81563	87877	93687	06313	12123	18437	9
52	33 4	26 56	81578	87866	93712	06288	12134	18422	8
53	32 56	27 4	81592	87855	93738	06262	12145	18408	7
54	32 48	27 12	81607	87844	93763	06237	12156	18393	6
55	6 32 40	5 27 20	9.81622	9.87833	9.93789	10.06211	10.12167	10.18378	5
56	32 32	27 28	81636	87822	93814	06186	12178	18364	4
57	32 24	27 36	81651	87811	93840	06160	12189	18349	3
58	32 16	27 44	81665	87800	93865	06135	12200	18335	2
59	32 8	27 52	81680	87789	93891	06109	12211	18320	1
60	32 0	28 0	81694	87778	93916	06084	12222	18306	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

130 Degs. Degs. 49.

Log. Sines, Tangents and Secants.

41 Degs. Degs. 138.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 32 0	5 28 0	9.81694	9.87778	9.93916	10.06084	10.12222	10.18306	60
1	31 52	28 8	81709	87767	93942	06058	12233	18291	59
2	31 44	28 16	81723	87756	93967	06033	12244	18277	58
3	31 36	28 24	81738	87745	93993	06007	12255	18262	57
4	31 28	28 32	81752	87734	94018	05982	12266	18248	56
5	6 31 20	5 28 40	9.81767	9.87723	9.94044	10.05956	10.12277	10.18233	55
6	31 12	28 48	81781	87712	94069	05931	12288	18219	54
7	31 4	28 56	81796	87701	94095	05905	12299	18204	53
8	30 56	29 4	81810	87690	94120	05880	12310	18190	52
9	30 48	29 12	81825	87679	94146	05854	12321	18175	51
10	6 30 40	5 29 20	9.81839	9.87668	9.94171	10.05829	10.12332	10.18161	50
11	30 32	29 28	81854	87657	94197	05803	12343	18146	49
12	30 24	29 36	81868	87646	94222	05778	12354	18132	48
13	30 16	29 44	81882	87635	94248	05752	12365	18118	47
14	30 8	29 52	81897	87624	94273	05727	12376	18103	46
15	6 30 0	5 30 0	9.81911	9.87613	9.94299	10.05701	10.12387	10.18089	45
16	29 52	30 8	81926	87601	94324	05676	12399	18074	44
17	29 44	30 16	81940	87590	94350	05650	12410	18060	43
18	29 36	30 24	81955	87579	94375	05625	12421	18045	42
19	29 28	30 32	81969	87568	94401	05599	12432	18031	41
20	6 29 20	5 30 40	9.81983	9.87557	9.94426	10.05574	10.12443	10.18017	40
21	29 12	30 48	81998	87546	94452	05548	12454	18002	39
22	29 4	30 56	82012	87535	94477	05523	12465	17988	38
23	28 56	31 4	82026	87524	94503	05497	12476	17974	37
24	28 48	31 12	82041	87513	94528	05472	12487	17959	36
25	6 28 40	5 31 20	9.82055	9.87501	9.94554	10.05446	10.12499	10.17945	35
26	28 32	31 28	82069	87490	94579	05421	12510	17931	34
27	28 24	31 36	82084	87479	94604	05396	12521	17916	33
28	28 16	31 44	82098	87468	94630	05370	12532	17902	32
29	28 8	31 52	82112	87457	94655	05345	12543	17888	31
30	6 28 0	5 32 0	9.82126	9.87446	9.94681	10.05319	10.12554	10.17874	30
31	27 52	32 8	82141	87434	94706	05294	12566	17859	29
32	27 44	32 16	82155	87423	94732	05268	12577	17845	28
33	27 36	32 24	82169	87412	94757	05243	12588	17831	27
34	27 28	32 32	82184	87401	94783	05217	12599	17816	26
35	6 27 20	5 32 40	9.82198	9.87390	9.94808	10.05192	10.12610	10.17802	25
36	27 12	32 48	82212	87378	94834	05166	12622	17788	24
37	27 4	32 56	82226	87367	94859	05141	12633	17774	23
38	26 56	33 4	82240	87356	94884	05116	12644	17760	22
39	26 48	33 12	82255	87345	94910	05090	12655	17745	21
40	6 26 40	5 33 20	9.82269	9.87334	9.94935	10.05065	10.12666	10.17731	20
41	26 32	33 28	82283	87322	94961	05039	12678	17717	19
42	26 24	33 36	82297	87311	94986	05014	12689	17703	18
43	26 16	33 44	82311	87300	95012	04988	12700	17689	17
44	26 8	33 52	82326	87288	95037	04963	12712	17674	16
45	6 26 0	5 34 0	9.82340	9.87277	9.95062	10.04938	10.12723	10.17660	15
46	25 52	34 8	82354	87266	95088	04912	12734	17646	14
47	25 44	34 16	82368	87255	95113	04887	12745	17632	13
48	25 36	34 24	82382	87243	95139	04861	12757	17618	12
49	25 28	34 32	82396	87232	95164	04836	12768	17604	11
50	6 25 20	5 34 40	9.82410	9.87221	9.95190	10.04810	10.12779	10.17590	10
51	25 12	34 48	82424	87209	95215	04785	12791	17576	9
52	25 4	34 56	82439	87198	95240	04760	12802	17561	8
53	24 56	35 4	82453	87187	95266	04734	12813	17547	7
54	24 48	35 12	82467	87175	95291	04709	12825	17533	6
55	6 24 40	5 35 20	9.82481	9.87164	9.95317	10.04683	10.12836	10.17519	5
56	24 32	35 28	82495	87153	95342	04658	12847	17505	4
57	24 24	35 36	82509	87141	95368	04632	12859	17491	3
58	24 16	35 44	82523	87130	95393	04607	12870	17477	2
59	24 8	35 52	82537	87119	95418	04582	12881	17463	1
60	24 0	36 0	82551	87107	95444	04556	12893	17449	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

131 Degs. Degs. 48.

TABLE XXVII.

Log. Sines, Tangents and Secants.

42 Degs. Degs. 137.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant.	M
0	6 24 0	5 36 0	9.82551	9.87107	9.95444	10.04556	10.12893	10.17449	60
1	23 52	36 8	82565	87096	95469	04531	12904	17435	59
2	23 44	36 16	82579	87085	95495	04505	12915	17421	58
3	23 36	36 24	82593	87073	95520	04480	12927	17407	57
4	23 28	36 32	82607	87062	95545	04455	12938	17393	56
5	6 23 20	5 36 40	9.82621	9.87050	9.95571	10.04429	10.12950	10.17379	55
6	23 12	36 48	82635	87039	95596	04404	12961	17365	54
7	23 4	36 56	82649	87028	95622	04378	12972	17351	53
8	22 56	37 4	82663	87016	95647	04353	12984	17337	52
9	22 48	37 12	82677	87005	95672	04328	12995	17323	51
10	6 22 40	5 37 20	9.82691	9.86993	9.95698	10.04302	10.13007	10.17309	50
11	22 32	37 28	82705	86982	95723	04277	13018	17295	49
12	22 24	37 36	82719	86970	95748	04252	13030	17281	48
13	22 16	37 44	82733	86959	95774	04226	13041	17267	47
14	22 8	37 52	82747	86947	95799	04201	13053	17253	46
15	6 22 0	5 38 0	9.82761	9.86936	9.95825	10.04175	10.13064	10.17239	45
16	21 52	38 8	82775	86924	95850	04150	13076	17225	44
17	21 44	38 16	82788	86913	95875	04125	13087	17212	43
18	21 36	38 24	82802	86902	95901	04099	13098	17198	42
19	21 28	38 32	82816	86890	95926	04074	13110	17184	41
20	6 21 20	5 38 40	9.82830	9.86879	9.95952	10.04048	10.13121	10.17170	40
21	21 12	38 48	82844	86867	95977	04023	13133	17156	39
22	21 4	38 56	82858	86855	96002	03998	13145	17142	38
23	20 56	39 4	82872	86844	96028	03972	13156	17128	37
24	20 48	39 12	82885	86832	96053	03947	13168	17115	36
25	6 20 40	5 39 20	9.82899	9.86821	9.96078	10.03922	10.13179	10.17101	35
26	20 32	39 28	82913	86809	96104	03896	13191	17087	34
27	20 24	39 36	82927	86798	96129	03871	13202	17073	33
28	20 16	39 44	82941	86786	96155	03845	13214	17059	32
29	20 8	39 52	82955	86775	96180	03820	13225	17045	31
30	6 20 0	5 40 0	9.82968	9.86763	9.96205	10.03795	10.13237	10.17032	30
31	19 52	40 8	82982	86752	96231	03769	13248	17018	29
32	19 44	40 16	82996	86740	96256	03744	13260	17004	28
33	19 36	40 24	83010	86728	96281	03719	13272	16990	27
34	19 28	40 32	83023	86717	96307	03693	13283	16977	26
35	6 19 20	5 40 40	9.83037	9.86705	9.96332	10.03668	10.13295	10.16963	25
36	19 12	40 48	83051	86694	96357	03643	13306	16949	24
37	19 4	40 56	83065	86682	96383	03617	13318	16935	23
38	18 56	41 4	83078	86670	96408	03592	13330	16922	22
39	18 48	41 12	83092	86659	96433	03567	13341	16908	21
40	6 18 40	5 41 20	9.83106	9.86647	9.96459	10.03541	10.13353	10.16894	20
41	18 32	41 28	83120	86635	96484	03516	13365	16880	19
42	18 24	41 36	83133	86624	96510	03490	13376	16867	18
43	18 16	41 44	83147	86612	96535	03465	13388	16853	17
44	18 8	41 52	83161	86600	96560	03440	13400	16839	16
45	6 18 0	5 42 0	9.83174	9.86589	9.96586	10.03414	10.13411	10.16826	15
46	17 52	42 8	83188	86577	96611	03389	13423	16812	14
47	17 44	42 16	83202	86565	96636	03364	13435	16798	13
48	17 36	42 24	83215	86554	96662	03338	13446	16785	12
49	17 28	42 32	83229	86542	96687	03313	13458	16771	11
50	6 17 20	5 42 40	9.83242	9.86530	9.96712	10.03288	10.13470	10.16758	10
51	17 12	42 48	83256	86518	96738	03262	13482	16744	9
52	17 4	42 56	83270	86507	96763	03237	13493	16730	8
53	16 56	43 4	83283	86495	96788	03212	13505	16717	7
54	16 48	43 12	83297	86483	96814	03186	13517	16703	6
55	6 16 40	5 43 20	9.83310	9.86472	9.96839	10.03161	10.13528	10.16690	5
56	16 32	43 28	83324	86460	96864	03136	13540	16676	4
57	16 24	43 36	83338	86448	96890	03110	13552	16662	3
58	16 16	43 44	83351	86436	96915	03085	13564	16649	2
59	16 8	43 52	83365	86425	96940	03060	13575	16635	1
60	16 0	44 0	83378	86413	96966	03034	13587	16622	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant.	Secant.	M

132 Degs. Degs. 47.

TABLE XXVII.

Log. Sines, Tangents and Secants.

43 Degs. Degs. 136.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	6 16 0	5 44 0	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622	60
1	15 52	44 8	83392	86401	96991	03009	13599	16608	59
2	15 44	44 16	83405	86389	97016	02984	13611	16595	58
3	15 36	44 24	83419	86377	97042	02958	13623	16581	57
4	15 28	44 32	83432	86366	97067	02933	13634	16568	56
5	6 15 20	5 44 40	9.83446	9.86354	9.97092	10.02908	10.13646	10.16554	55
6	15 12	44 48	83459	86342	97118	02882	13658	16541	54
7	15 4	44 56	83473	86330	97143	02857	13670	16527	53
8	14 56	45 4	83486	86318	97168	02832	13682	16514	52
9	14 48	45 12	83500	86306	97193	02807	13694	16500	51
10	6 14 40	5 45 20	9.83513	9.86295	9.97219	10.02781	10.13705	10.16487	50
11	14 32	45 28	83527	86283	97244	02756	13717	16473	49
12	14 24	45 36	83540	86271	97269	02731	13729	16460	48
13	14 16	45 44	83554	86259	97295	02705	13741	16446	47
14	14 8	45 52	83567	86247	97320	02680	13753	16433	46
15	6 14 0	5 46 0	9.83581	9.86235	9.97345	10.02655	10.13765	10.16419	45
16	13 52	46 8	83594	86223	97371	02629	13777	16406	44
17	13 44	46 16	83608	86211	97396	02604	13789	16392	43
18	13 36	46 24	83621	86200	97421	02579	13800	16379	42
19	13 28	46 32	83634	86188	97447	02553	13812	16366	41
20	6 13 20	5 46 40	9.83648	9.86176	9.97472	10.02528	10.13824	10.16352	40
21	13 12	46 48	83661	86164	97497	02503	13836	16339	39
22	13 4	46 56	83674	86152	97523	02477	13848	16326	38
23	12 56	47 4	83688	86140	97548	02452	13860	16312	37
24	12 48	47 12	83701	86128	97573	02427	13872	16299	36
25	6 12 40	5 47 20	9.83715	9.86116	9.97598	10.02402	10.13884	10.16285	35
26	12 32	47 28	83728	86104	97624	02376	13896	16272	34
27	12 24	47 36	83741	86092	97649	02351	13908	16259	33
28	12 16	47 44	83755	86080	97674	02326	13920	16245	32
29	12 8	47 52	83768	86068	97700	02300	13932	16232	31
30	6 12 0	5 48 0	9.83781	9.86056	9.97725	10.02275	10.13944	10.16219	30
31	11 52	48 8	83795	86044	97750	02250	13956	16205	29
32	11 44	48 16	83808	86032	97776	02224	13968	16192	28
33	11 36	48 24	83821	86020	97801	02199	13980	16179	27
34	11 28	48 32	83834	86008	97826	02174	13992	16166	26
35	6 11 20	5 48 40	9.83848	9.85996	9.97851	10.02149	10.14004	10.16152	25
36	11 12	48 48	83861	85984	97877	02123	14016	16139	24
37	11 4	48 56	83874	85972	97902	02098	14028	16126	23
38	10 56	49 4	83887	85960	97927	02073	14040	16113	22
39	10 48	49 12	83901	85948	97953	02047	14052	16099	21
40	6 10 40	5 49 20	9.83914	9.85936	9.97978	10.02022	10.14064	10.16086	20
41	10 32	49 28	83927	85924	98003	01997	14076	16073	19
42	10 24	49 36	83940	85912	98029	01971	14088	16060	18
43	10 16	49 44	83954	85900	98054	01946	14100	16046	17
44	10 8	49 52	83967	85888	98079	01921	14112	16033	16
45	6 10 0	5 50 0	9.83980	9.85876	9.98104	10.01896	10.14124	10.16020	15
46	9 52	50 8	83993	85864	98130	01870	14136	16007	14
47	9 44	50 16	84006	85851	98155	01845	14149	15994	13
48	9 36	50 24	84020	85839	98180	01820	14161	15980	12
49	9 28	50 32	84033	85827	98206	01794	14173	15967	11
50	6 9 20	5 50 40	9.84046	9.85815	9.98231	10.01769	10.14185	10.15954	10
51	9 12	50 48	84059	85803	98256	01744	14197	15941	9
52	9 4	50 56	84072	85791	98281	01719	14209	15928	8
53	8 56	51 4	84085	85779	98307	01693	14221	15915	7
54	8 48	51 12	84098	85766	98332	01668	14234	15902	6
55	6 8 40	5 51 20	9.84112	9.85754	9.98357	10.01643	10.14246	10.15888	5
56	8 32	51 28	84125	85742	98383	01617	14258	15875	4
57	8 24	51 36	84138	85730	98408	01592	14270	15862	3
58	8 16	51 44	84151	85718	98433	01567	14282	15849	2
59	8 8	51 52	84164	85706	98458	01542	14294	15836	1
60	8 0	52 0	84177	85693	98484	01516	14307	15823	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

133 Degs. Degs. 46

TABLE XXVII.

Log. Sines, Tangents and Secants.

44 Degs. | Degs. 135.

M	Hour A.M.	Hour P.M.	Sine.	Co-sine.	Tangent.	Co-tang.	Secant.	Co-secant	M
0	6 8 0	5 52 0	9.84177	9.85693	9.98484	10.01516	10.14307	10.15823	60
1	7 52	52 8	84190	85681	98509	01491	14319	15810	59
2	7 44	52 16	84203	85669	98534	01466	14331	15797	58
3	7 36	52 24	84216	85657	98560	01440	14343	15784	57
4	7 28	52 32	84229	85645	98585	01415	14355	15771	56
5	6 7 20	5 52 40	9.84242	9.85632	9.98610	10.01390	10.14368	10.15758	55
6	7 12	52 48	84255	85620	98635	01365	14380	15745	54
7	7 4	52 56	84269	85608	98661	01339	14392	15731	53
8	6 56	53 4	84282	85596	98686	01314	14404	15718	52
9	6 48	53 12	84295	85583	98711	01289	14417	15705	51
10	6 6 40	5 53 20	9.84308	9.85571	9.98737	10.01263	10.14429	10.15692	50
11	6 32	53 28	84321	85559	98762	01238	14441	15679	49
12	6 24	53 36	84334	85547	98787	01213	14453	15666	48
13	6 16	53 44	84347	85534	98812	01188	14466	15653	47
14	6 8	53 52	84360	85522	98838	01162	14478	15640	46
15	6 6 0	5 54 0	9.84373	9.85510	9.98863	10.01137	10.14490	10.15627	45
16	5 52	54 8	84385	85497	98888	01112	14503	15615	44
17	5 44	54 16	84398	85485	98913	01087	14515	15602	43
18	5 36	54 24	84411	85473	98939	01061	14527	15589	42
19	5 28	54 32	84424	85460	98964	01036	14540	15576	41
20	6 5 20	5 54 40	9.84437	9.85448	9.98989	10.01011	10.14552	10.15563	40
21	5 12	54 48	84450	85436	99015	00985	14564	15550	39
22	5 4	54 56	84463	85423	99040	00960	14577	15537	38
23	4 56	55 4	84476	85411	99065	00935	14589	15524	37
24	4 48	55 12	84489	85399	99090	00910	14601	15511	36
25	6 4 40	5 55 20	9.84502	9.85386	9.99116	10.00884	10.14614	10.15498	35
26	4 32	55 28	84515	85374	99141	00859	14626	15485	34
27	4 24	55 36	84528	85361	99166	00834	14639	15472	33
28	4 16	55 44	84540	85349	99191	00809	14651	15460	32
29	4 8	55 52	84553	85337	99217	00783	14663	15447	31
30	6 4 0	5 56 0	9.84566	9.85324	9.99242	10.00758	10.14676	10.15434	30
31	3 52	56 8	84579	85312	99267	00733	14688	15421	29
32	3 44	56 16	84592	85299	99293	00707	14701	15408	28
33	3 36	56 24	84605	85287	99318	00682	14713	15395	27
34	3 28	56 32	84618	85274	99343	00657	14726	15382	26
35	6 3 20	5 56 40	9.84630	9.85262	9.99368	10.00632	10.14738	10.15370	25
36	3 12	56 48	84643	85250	99394	00606	14750	15357	24
37	3 4	56 56	84656	85237	99419	00581	14763	15344	23
38	2 56	57 4	84669	85225	99444	00556	14775	15331	22
39	2 48	57 12	84682	85212	99469	00531	14788	15318	21
40	6 2 40	5 57 20	9.84694	9.85200	9.99495	10.00505	10.14800	10.15306	20
41	2 32	57 28	84707	85187	99520	00480	14813	15293	19
42	2 24	57 36	84720	85175	99545	00455	14825	15280	18
43	2 16	57 44	84733	85162	99570	00430	14838	15267	17
44	2 8	57 52	84745	85150	99596	00404	14850	15255	16
45	6 2 0	5 58 0	9.84758	9.85137	9.99621	10.00379	10.14863	10.15242	15
46	1 52	58 8	84771	85125	99646	00354	14875	15229	14
47	1 44	58 16	84784	85112	99672	00328	14888	15216	13
48	1 36	58 24	84796	85100	99697	00303	14900	15204	12
49	1 28	58 32	84809	85087	99722	00278	14913	15191	11
50	6 1 20	5 58 40	9.84822	9.85074	9.99747	10.00253	10.14926	10.15178	10
51	1 12	58 48	84835	85062	99773	00227	14938	15165	9
52	1 4	58 56	84847	85049	99798	00202	14951	15153	8
53	0 56	59 4	84860	85037	99823	00177	14963	15140	7
54	0 48	59 12	84873	85024	99848	00152	14976	15127	6
55	6 0 40	5 59 20	9.84885	9.85012	9.99874	10.00126	10.14988	10.15115	5
56	0 32	59 28	84898	84999	99899	00101	15001	15102	4
57	0 24	59 36	84911	84986	99924	00076	15014	15089	3
58	0 16	59 44	84923	84974	99949	00051	15026	15077	2
59	0 8	59 52	84936	84961	99975	00025	15039	15064	1
60	0 0	6 0 0	84949	84949	10.00000	00000	15051	15051	0
M	Hour P.M.	Hour A.M.	Co-sine.	Sine.	Co-tang.	Tangent.	Co-secant	Secant.	M

134 Degs. | Degs. 45.

Table XXVIII. For reducing the time of the Moon's passage over the Meridian of Greenwich to the Time of its passage over any other Meridian.

The numbers taken from this Table are to be added to the Time at Greenwich in West Longitude, but subtracted in East.

Daily variation of the Moon's passing the Meridian.

Sh's Lon.	40′	42′	44′	46′	48′	50′	52′	54′	56′	58′	60′	62′	64′	66′	Sh's Lon.
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
10	1	1	1	1	1	1	1	1	2	2	2	2	2	2	10
15	2	2	2	2	2	2	2	2	2	2	2	3	3	3	15
20	2	2	2	3	3	3	3	3	3	3	3	3	4	4	20
25	3	3	3	3	3	3	4	4	4	4	4	4	4	5	25
30	3	3	4	4	4	4	4	4	5	5	5	5	5	5	30
35	4	4	4	4	5	5	5	5	5	6	6	6	6	6	35
40	4	5	5	5	5	6	6	6	6	6	7	7	7	7	40
45	5	5	5	6	6	6	6	7	7	7	7	8	8	8	45
50	6	6	6	6	7	7	7	7	8	8	8	9	9	9	50
55	6	6	7	7	7	8	8	8	9	9	9	9	10	10	55
60	7	7	7	8	8	8	9	9	9	10	10	10	11	11	60
65	7	8	8	8	9	9	9	10	10	10	11	11	12	12	65
70	8	8	9	9	9	10	10	10	11	11	12	12	12	13	70
75	8	9	9	10	10	10	11	11	12	12	12	13	13	14	75
80	9	9	10	10	11	11	12	12	12	13	13	14	14	15	80
85	9	10	10	11	11	12	12	13	13	14	14	15	15	16	85
90	10	10	11	11	12	12	13	13	14	14	15	15	16	16	90
95	11	11	12	12	13	13	14	14	15	15	16	16	17	17	95
100	11	12	12	13	13	14	14	15	16	16	17	17	18	18	100
105	12	12	13	13	14	15	15	16	16	17	17	18	19	19	105
110	12	13	13	14	15	15	16	16	17	18	18	19	20	20	110
115	13	13	14	15	15	16	17	17	18	19	19	20	20	21	115
120	13	14	15	15	16	17	17	18	19	19	20	21	21	22	120
125	14	15	15	16	17	17	18	19	19	20	21	22	22	23	125
130	14	15	16	17	17	18	19	19	20	21	22	22	23	24	130
135	15	16	16	17	18	19	19	20	21	22	22	23	24	25	135
140	16	16	17	18	19	19	20	21	22	23	23	24	25	26	140
145	16	17	18	19	19	20	21	22	23	23	24	25	26	27	145
150	17	17	18	19	20	21	22	22	23	24	25	26	27	27	150
155	17	18	19	20	21	22	22	23	24	25	26	27	28	28	155
160	18	19	20	20	21	22	23	24	25	26	27	28	28	29	160
165	18	19	20	21	22	23	24	25	26	27	27	28	29	30	165
170	19	20	21	22	23	24	25	25	26	27	28	29	30	31	170
175	19	20	21	22	23	24	25	26	27	28	29	30	31	32	175
180	20	21	22	23	24	25	26	27	28	29	30	31	32	33	180
	40′	42′	44′	46′	48′	50′	52′	54′	56′	58′	60′	62′	64′	66′	

Table XXIX. Correction of moon's altitude for Parallax and Refraction.

☽ alt Deg.	Corr Min.	☽ alt Deg.	Corr Min.
10	51	51	35
11	52	52	35
12	52	53	34
13	52	54	33
14	52	55	32
15	52	56	32
16	52	57	31
17	52	58	30
18	52	59	29
19	52	60	28
20	51		
21	51	61	27
22	51	62	26
23	51	63	26
24	50	64	25
25	50	65	24
26	50	66	23
27	49	67	22
28	49	68	21
29	49	69	20
30	48	70	19
31	48	71	18
32	47	72	17
33	47	73	17
34	46	74	16
35	46	75	15
36	45	76	14
37	45	77	13
38	44	78	12
39	44	79	11
40	43	80	10
41	42	81	9
42	42	82	8
43	41	83	7
44	40	84	6
45	40	85	5
46	39	86	4
47	38	87	3
48	38	88	2
49	37	89	1
50	36	90	0

TABLE XXX.

'or reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours.													Time from Noon.
	° ′ 0 5	° ′ 0 10	° ′ 0 15	° ′ 0 20	° ′ 0 25	° ′ 0 30	° ′ 0 35	° ′ 0 40	° ′ 0 45	° ′ 0 50	° ′ 0 55	° ′ 1 0	° ′ 1 5	
0h 0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0′	0° 0′	12h 0′
0 12	0	0	0	0	0	0	1	1	1	1	1	1	0 1	12 12
0 24	0	0	0	1	1	1	1	1	1	2	2	2	0 2	12 24
0 36	0	0	1	1	1	1	2	2	2	2	3	3	0 3	12 36
0 48	0	1	1	1	2	2	2	3	3	3	4	4	0 4	12 48
1 0	0	1	1	2	2	2	3	3	4	4	5	5	0 5	13 0
1 12	0	1	1	2	2	3	3	4	4	5	5	6	0 6	13 12
1 24	1	1	2	2	3	3	4	5	5	6	6	7	0 8	13 24
1 36	1	1	2	3	3	4	5	5	6	7	7	8	0 9	13 36
1 48	1	1	2	3	4	4	5	6	7	7	8	9	0 10	13 48
2 0	1	2	2	3	4	5	6	7	7	8	9	10	0 11	14 0
2 12	1	2	3	4	5	5	6	7	8	9	10	11	0 12	14 12
2 24	1	2	3	4	5	6	7	8	9	10	11	12	0 13	14 24
2 36	1	2	3	4	5	6	8	9	10	11	12	13	0 14	14 36
2 48	1	2	3	5	6	7	8	9	10	12	13	14	0 15	14 48
3 0	1	2	4	5	6	7	9	10	11	12	14	15	0 16	15 0
3 12	1	3	4	5	7	8	9	11	12	13	15	16	0 17	15 12
3 24	1	3	4	6	7	8	10	11	13	14	16	17	0 18	15 24
3 36	1	3	4	6	7	9	10	12	13	15	16	18	0 19	15 36
3 48	2	3	5	6	8	9	11	13	14	16	17	19	0 21	15 48
4 0	2	3	5	7	8	10	12	13	15	17	18	20	0 22	16 0
4 12	2	3	5	7	9	10	12	14	16	17	19	21	0 23	16 12
4 24	2	4	5	7	9	11	13	15	16	18	20	22	0 24	16 24
4 36	2	4	6	8	10	11	13	15	17	19	21	23	0 25	16 36
4 48	2	4	6	8	10	12	14	16	18	20	22	24	0 26	16 48
5 0	2	4	6	8	10	12	15	17	19	21	23	25	0 27	17 0
5 12	2	4	6	9	11	13	15	17	19	22	24	26	0 28	17 12
5 24	2	4	7	9	11	13	16	18	20	22	25	27	0 29	17 24
5 36	2	5	7	9	12	14	16	19	21	23	26	28	0 30	17 36
5 48	2	5	7	10	12	14	17	19	22	24	27	29	0 31	17 48
6 0	2	5	7	10	12	15	17	20	22	25	27	30	0 32	18 0
6 12	3	5	8	10	13	15	18	21	23	26	28	31	0 34	18 12
6 24	3	5	8	11	13	16	19	21	24	27	29	32	0 35	18 24
6 36	3	5	8	11	14	16	19	22	25	27	30	33	0 36	18 36
6 48	3	6	8	11	14	17	20	23	25	28	31	34	0 37	18 48
7 0	3	6	9	12	15	17	20	23	26	29	32	35	0 38	19 0
7 12	3	6	9	12	15	18	21	24	27	30	33	36	0 39	19 12
7 24	3	6	9	12	15	18	22	25	28	31	34	37	0 40	19 24
7 36	3	6	9	13	16	19	22	25	28	32	35	38	0 41	19 36
7 48	3	6	10	13	16	19	23	26	29	32	36	39	0 42	19 48
8 0	3	7	10	13	17	20	23	27	30	33	37	40	0 43	20 0
8 12	3	7	10	14	17	20	24	27	31	34	38	41	0 44	20 12
8 24	3	7	10	14	17	21	24	28	31	35	38	42	0 45	20 24
8 36	4	7	11	14	18	21	25	29	32	36	39	43	0 47	20 36
8 48	4	7	11	15	18	22	26	29	33	37	40	44	0 48	20 48
9 0	4	7	11	15	19	22	26	30	34	37	41	45	0 49	21 0
9 12	4	8	11	15	19	23	27	31	34	38	42	46	0 50	21 12
9 24	4	8	12	16	20	23	27	31	35	39	43	47	0 51	21 24
9 36	4	8	12	16	20	24	28	32	36	40	44	48	0 52	21 36
9 48	4	8	12	16	20	24	29	33	37	41	45	49	0 53	21 48
0 0	4	8	12	17	21	25	29	33	37	42	46	50	0 54	22 0
0 12	4	8	13	17	21	25	30	34	38	42	47	51	0 55	22 12
0 24	4	9	13	17	22	26	30	35	39	43	48	52	0 56	22 24
0 36	4	9	13	18	22	26	31	35	40	44	49	53	0 57	22 36
0 48	4	9	13	18	22	27	31	36	40	45	49	54	0 58	22 48
1 0	5	9	14	18	23	27	32	37	41	46	50	55	1 0	23 0
1 12	5	9	14	19	23	28	33	37	42	47	51	56	1 1	23 12
1 24	5	9	14	19	24	28	33	38	43	47	52	57	1 2	23 24
1 36	5	10	14	19	24	29	34	39	43	48	53	58	1 3	23 36
1 48	5	10	15	20	25	29	34	39	44	49	54	59	1 4	23 48
2 0	5	10	15	20	25	30	35	40	45	50	55	60	1 5	24 0

TABLE XXX.

For reducing the Moon's Declination, as given in the Nautical Almanac for Noon Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours. 1° 10′	1° 15′	1° 20′	1° 25′	1° 30′	1° 35′	1° 40′	1° 45′	1° 50′	1° 55′	Time from Noon.
0h 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	12h 0′
0 12	0 1	0 1	0 1	0 1	0 1	0 2	0 2	0 2	0 2	0 2	12 12
0 24	0 2	0 2	0 3	0 3	0 3	0 3	0 3	0 3	0 4	0 4	12 24
0 36	0 3	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 6	12 36
0 48	0 5	0 5	0 5	0 6	0 6	0 6	0 7	0 7	0 7	0 8	12 48
1 0	0 6	0 6	0 7	0 7	0 7	0 8	0 8	0 9	0 9	0 10	13 0
1 12	0 7	0 7	0 8	0 8	0 9	0 9	0 10	0 10	0 11	0 11	13 12
1 24	0 8	0 9	0 9	0 10	0 10	0 11	0 12	0 12	0 13	0 13	13 24
1 36	0 9	0 10	0 11	0 11	0 12	0 13	0 13	0 14	0 15	0 15	13 36
1 48	0 10	0 11	0 12	0 13	0 13	0 14	0 15	0 16	0 16	0 17	13 48
2 0	0 12	0 12	0 13	0 14	0 15	0 16	0 17	0 17	0 18	0 19	14 0
2 12	0 13	0 14	0 15	0 16	0 16	0 17	0 18	0 19	0 20	0 21	14 12
2 24	0 14	0 15	0 16	0 17	0 18	0 19	0 20	0 21	0 22	0 23	14 24
2 36	0 15	0 16	0 17	0 18	0 19	0 21	0 22	0 23	0 24	0 25	14 36
2 48	0 16	0 17	0 19	0 20	0 21	0 22	0 23	0 24	0 26	0 27	14 48
3 0	0 17	0 19	0 20	0 21	0 22	0 24	0 25	0 26	0 27	0 29	15 0
3 12	0 19	0 20	0 21	0 23	0 24	0 25	0 27	0 28	0 29	0 31	15 12
3 24	0 20	0 21	0 23	0 24	0 25	0 27	0 28	0 30	0 31	0 33	15 24
3 36	0 21	0 22	0 24	0 25	0 27	0 28	0 30	0 31	0 33	0 34	15 36
3 48	0 22	0 24	0 25	0 27	0 28	0 30	0 32	0 33	0 35	0 36	15 48
4 0	0 23	0 25	0 27	0 28	0 30	0 32	0 33	0 35	0 37	0 38	16 0
4 12	0 24	0 26	0 28	0 30	0 31	0 33	0 35	0 37	0 38	0 40	16 12
4 24	0 26	0 27	0 29	0 31	0 33	0 35	0 37	0 38	0 40	0 42	16 24
4 36	0 27	0 29	0 31	0 33	0 34	0 36	0 38	0 40	0 42	0 44	16 36
4 48	0 28	0 30	0 32	0 34	0 36	0 38	0 40	0 42	0 44	0 46	16 48
5 0	0 29	0 31	0 33	0 35	0 37	0 40	0 42	0 44	0 46	0 48	17 0
5 12	0 30	0 32	0 35	0 37	0 39	0 41	0 43	0 45	0 48	0 50	17 12
5 24	0 31	0 34	0 36	0 38	0 40	0 43	0 45	0 47	0 49	0 52	17 24
5 36	0 33	0 35	0 37	0 40	0 42	0 44	0 47	0 49	0 51	0 54	17 36
5 48	0 34	0 36	0 39	0 41	0 43	0 46	0 48	0 51	0 53	0 56	17 48
6 0	0 35	0 37	0 40	0 42	0 45	0 47	0 50	0 52	0 55	0 57	18 0
6 12	0 36	0 39	0 41	0 44	0 46	0 49	0 52	0 54	0 57	0 59	18 12
6 24	0 37	0 40	0 43	0 45	0 48	0 51	0 53	0 56	0 59	1 1	18 24
6 36	0 38	0 41	0 44	0 47	0 49	0 52	0 55	0 58	1 0	1 3	18 36
6 48	0 40	0 42	0 45	0 48	0 51	0 54	0 57	0 59	1 2	1 5	18 48
7 0	0 41	0 44	0 47	0 50	0 52	0 55	0 58	1 1	1 4	1 7	19 0
7 12	0 42	0 45	0 48	0 51	0 54	0 57	1 0	1 3	1 6	1 9	19 12
7 24	0 43	0 46	0 49	0 52	0 55	0 59	1 2	1 5	1 8	1 11	19 24
7 36	0 44	0 47	0 51	0 54	0 57	1 0	1 3	1 6	1 10	1 13	19 36
7 48	0 45	0 49	0 52	0 55	0 58	1 2	1 5	1 8	1 11	1 15	19 48
8 0	0 47	0 50	0 53	0 57	1 0	1 3	1 7	1 10	1 13	1 17	20 0
8 12	0 48	0 51	0 55	0 58	1 1	1 5	1 8	1 12	1 15	1 19	20 12
8 24	0 49	0 52	0 56	0 59	1 3	1 6	1 10	1 13	1 17	1 20	20 24
8 36	0 50	0 54	0 57	1 1	1 4	1 8	1 12	1 15	1 19	1 22	20 36
8 48	0 51	0 55	0 59	1 2	1 6	1 10	1 13	1 17	1 21	1 24	20 48
9 0	0 52	0 56	1 0	1 4	1 7	1 11	1 15	1 19	1 22	1 26	21 0
9 12	0 54	0 57	1 1	1 5	1 9	1 13	1 17	1 20	1 24	1 28	21 12
9 24	0 55	0 59	1 3	1 7	1 10	1 14	1 18	1 22	1 26	1 30	21 24
9 36	0 56	1 0	1 4	1 8	1 12	1 16	1 20	1 24	1 28	1 32	21 36
9 48	0 57	1 1	1 5	1 9	1 13	1 18	1 22	1 26	1 30	1 34	21 48
10 0	0 58	1 2	1 7	1 11	1 15	1 19	1 23	1 27	1 32	1 36	22 0
10 12	0 59	1 4	1 8	1 12	1 16	1 21	1 25	1 29	1 33	1 38	22 12
10 24	1 1	1 5	1 9	1 14	1 18	1 22	1 27	1 31	1 35	1 40	22 24
10 36	1 2	1 6	1 11	1 15	1 19	1 24	1 28	1 33	1 37	1 42	22 36
10 48	1 3	1 7	1 12	1 16	1 21	1 25	1 30	1 34	1 39	1 43	22 48
11 0	1 4	1 9	1 13	1 18	1 22	1 27	1 32	1 36	1 41	1 45	23 0
11 12	1 5	1 10	1 15	1 19	1 24	1 29	1 33	1 38	1 43	1 47	23 12
11 24	1 6	1 11	1 16	1 21	1 25	1 30	1 35	1 40	1 44	1 49	23 24
11 36	1 8	1 12	1 17	1 22	1 27	1 32	1 37	1 41	1 46	1 51	23 36
11 48	1 9	1 14	1 19	1 24	1 28	1 33	1 38	1 43	1 48	1 53	23 48
12 0	1 10	1 15	1 20	1 25	1 30	1 35	1 40	1 45	1 50	1 55	24 0

TABLE XXX.

For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours. 2° 0′	2° 5′	2° 10′	2° 15′	2° 20′	2° 25′	2° 30′	2° 35′	2° 40′	2° 45′	2° 50′	Time from Noon.
0h 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	12h 0′
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 3	0 3	0 3	0 3	12 12
0 24	0 4	0 4	0 4	0 4	0 5	0 5	0 5	0 5	0 5	0 5	0 6	12 24
0 36	0 6	0 6	0 6	0 7	0 7	0 7	0 7	0 8	0 8	0 8	0 8	12 36
0 48	0 8	0 8	0 9	0 9	0 9	0 10	0 10	0 10	0 11	0 11	0 11	12 48
1 0	0 10	0 10	0 11	0 11	0 12	0 12	0 12	0 13	0 13	0 14	0 14	13 0
1 12	0 12	0 12	0 13	0 13	0 14	0 14	0 15	0 15	0 16	0 16	0 17	13 12
1 24	0 14	0 15	0 15	0 16	0 16	0 17	0 17	0 18	0 19	0 19	0 20	13 24
1 36	0 16	0 17	0 17	0 18	0 19	0 19	0 20	0 21	0 21	0 22	0 23	13 36
1 48	0 18	0 19	0 19	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 25	13 48
2 0	0 20	0 21	0 22	0 22	0 23	0 24	0 25	0 26	0 27	0 27	0 28	14 0
2 12	0 22	0 23	0 24	0 25	0 26	0 27	0 27	0 28	0 29	0 30	0 31	14 12
2 24	0 24	0 25	0 26	0 27	0 28	0 29	0 30	0 31	0 32	0 33	0 34	14 24
2 36	0 26	0 27	0 28	0 29	0 30	0 31	0 32	0 34	0 35	0 36	0 37	14 36
2 48	0 28	0 29	0 30	0 31	0 33	0 34	0 35	0 36	0 37	0 38	0 40	14 48
3 0	0 30	0 31	0 32	0 34	0 35	0 36	0 37	0 39	0 40	0 41	0 42	15 0
3 12	0 32	0 33	0 35	0 36	0 37	0 39	0 40	0 41	0 43	0 44	0 45	15 12
3 24	0 34	0 35	0 37	0 38	0 40	0 41	0 42	0 44	0 45	0 47	0 48	15 24
3 36	0 36	0 37	0 39	0 40	0 42	0 43	0 45	0 46	0 48	0 49	0 51	15 36
3 48	0 38	0 40	0 41	0 43	0 44	0 46	0 47	0 49	0 51	0 52	0 54	15 48
4 0	0 40	0 42	0 43	0 45	0 47	0 48	0 50	0 52	0 53	0 55	0 57	16 0
4 12	0 42	0 44	0 45	0 47	0 49	0 51	0 52	0 54	0 56	0 58	0 59	16 12
4 24	0 44	0 46	0 48	0 49	0 51	0 53	0 55	0 57	0 59	1 0	1 2	16 24
4 36	0 46	0 48	0 50	0 52	0 54	0 56	0 57	0 59	1 1	1 3	1 5	16 36
4 48	0 48	0 50	0 52	0 54	0 56	0 58	1 0	1 2	1 4	1 6	1 8	16 48
5 0	0 50	0 52	0 54	0 56	0 58	1 0	1 2	1 5	1 7	1 9	1 11	17 0
5 12	0 52	0 54	0 56	0 58	1 1	1 3	1 5	1 7	1 9	1 11	1 14	17 12
5 24	0 54	0 56	0 58	1 1	1 3	1 5	1 7	1 10	1 12	1 14	1 16	17 24
5 36	0 56	0 58	1 1	1 3	1 5	1 8	1 10	1 12	1 15	1 17	1 19	17 36
5 48	0 58	1 0	1 3	1 5	1 8	1 10	1 12	1 15	1 17	1 20	1 22	17 48
6 0	1 0	1 2	1 5	1 7	1 10	1 12	1 15	1 17	1 20	1 22	1 25	18 0
6 12	1 2	1 5	1 7	1 10	1 12	1 15	1 17	1 20	1 23	1 25	1 28	18 12
6 24	1 4	1 7	1 9	1 12	1 15	1 17	1 20	1 23	1 25	1 28	1 31	18 24
6 36	1 6	1 9	1 11	1 14	1 17	1 20	1 22	1 25	1 28	1 31	1 33	18 36
6 48	1 8	1 11	1 14	1 16	1 19	1 22	1 25	1 28	1 31	1 33	1 36	18 48
7 0	1 10	1 13	1 16	1 19	1 22	1 25	1 27	1 30	1 33	1 36	1 39	19 0
7 12	1 12	1 15	1 18	1 21	1 24	1 27	1 30	1 33	1 36	1 39	1 42	19 12
7 24	1 14	1 17	1 20	1 23	1 26	1 29	1 32	1 36	1 39	1 42	1 45	19 24
7 36	1 16	1 19	1 22	1 25	1 29	1 32	1 35	1 38	1 41	1 44	1 48	19 36
7 48	1 18	1 21	1 24	1 28	1 31	1 34	1 37	1 41	1 44	1 47	1 50	19 48
8 0	1 20	1 23	1 27	1 30	1 33	1 37	1 40	1 43	1 47	1 50	1 53	20 0
8 12	1 22	1 25	1 29	1 32	1 36	1 39	1 42	1 46	1 49	1 53	1 56	20 12
8 24	1 24	1 27	1 31	1 34	1 38	1 41	1 45	1 48	1 52	1 55	1 59	20 24
8 36	1 26	1 30	1 33	1 37	1 40	1 44	1 47	1 51	1 55	1 58	2 2	20 36
8 48	1 28	1 32	1 35	1 39	1 43	1 46	1 50	1 54	1 57	2 1	2 5	20 48
9 0	1 30	1 34	1 37	1 41	1 45	1 49	1 52	1 56	2 0	2 4	2 7	21 0
9 12	1 32	1 36	1 40	1 43	1 47	1 51	1 55	1 59	2 3	2 6	2 10	21 12
9 24	1 34	1 38	1 42	1 46	1 50	1 54	1 57	2 1	2 5	2 9	2 13	21 24
9 36	1 36	1 40	1 44	1 48	1 52	1 56	2 0	2 4	2 8	2 12	2 16	21 36
9 48	1 38	1 42	1 46	1 50	1 54	1 58	2 2	2 7	2 11	2 15	2 19	21 48
10 0	1 40	1 44	1 48	1 52	1 57	2 1	2 5	2 9	2 13	2 17	2 22	22 0
10 12	1 42	1 46	1 50	1 55	1 59	2 3	2 7	2 12	2 16	2 20	2 24	22 12
10 24	1 44	1 48	1 53	1 57	2 1	2 6	2 10	2 14	2 19	2 23	2 27	22 24
10 36	1 46	1 50	1 55	1 59	2 4	2 8	2 12	2 17	2 21	2 26	2 30	22 36
10 48	1 48	1 52	1 57	2 1	2 6	2 10	2 15	2 19	2 24	2 28	2 33	22 48
11 0	1 50	1 55	1 59	2 4	2 8	2 13	2 17	2 22	2 27	2 31	2 36	23 0
11 12	1 52	1 57	2 1	2 6	2 11	2 15	2 20	2 25	2 29	2 34	2 39	23 12
11 24	1 54	1 59	2 3	2 8	2 13	2 18	2 22	2 27	2 32	2 37	2 41	23 24
11 36	1 56	2 1	2 6	2 10	2 15	2 20	2 25	2 30	2 35	2 39	2 44	23 36
11 48	1 58	2 3	2 8	2 13	2 18	2 23	2 27	2 32	2 37	2 42	2 47	23 48
12 0	2 0	2 5	2 10	2 15	2 20	2 25	2 30	2 35	2 40	2 45	2 50	24 0

TABLE XXX.

For reducing the Moon's Declination, as given in the Nautical Almanac for Noon and Midnight at Greenwich, to any other time under any other Meridian.

Time from Noon.	Variation of the Moon's Declination in twelve Hours. ° ′ 2 55	° ′ 3 0	° ′ 3 5	° ′ 3 10	° ′ 3 15	° ′ 3 20	° ′ 3 25	° ′ 3 30	° ′ 3 35	° ′ 3 40	° ′ 3 45	Time from Noon.
0h 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	12h 0′
0 12	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 3	0 4	0 4	0 4	12 12
0 24	0 6	0 6	0 6	0 6	0 6	0 7	0 7	0 7	0 7	0 7	0 7	12 24
0 36	0 9	0 9	0 9	0 9	0 10	0 10	0 10	0 10	0 11	0 11	0 11	12 36
0 48	0 12	0 12	0 12	0 13	0 13	0 13	0 14	0 14	0 14	0 15	0 15	12 48
1 0	0 15	0 15	0 15	0 16	0 16	0 17	0 17	0 17	0 18	0 18	0 19	13 0
1 12	0 17	0 18	0 18	0 19	0 19	0 20	0 20	0 21	0 21	0 22	0 22	13 12
1 24	0 20	0 21	0 22	0 22	0 23	0 23	0 24	0 24	0 25	0 26	0 26	13 24
1 36	0 23	0 24	0 25	0 25	0 26	0 27	0 27	0 28	0 29	0 29	0 30	13 36
1 48	0 26	0 27	0 28	0 28	0 29	0 30	0 31	0 31	0 32	0 33	0 34	13 48
2 0	0 29	0 30	0 31	0 32	0 32	0 33	0 34	0 35	0 36	0 37	0 37	14 0
2 12	0 32	0 33	0 34	0 35	0 36	0 37	0 38	0 38	0 39	0 40	0 41	14 12
2 24	0 35	0 36	0 37	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	14 24
2 36	0 38	0 39	0 40	0 41	0 42	0 43	0 44	0 45	0 47	0 48	0 49	14 36
2 48	0 41	0 42	0 43	0 44	0 45	0 47	0 48	0 49	0 50	0 51	0 52	14 48
3 0	0 44	0 45	0 46	0 47	0 49	0 50	0 51	0 52	0 54	0 55	0 56	15 0
3 12	0 47	0 48	0 49	0 51	0 52	0 53	0 55	0 56	0 57	0 59	1 0	15 12
3 24	0 50	0 51	0 52	0 54	0 55	0 57	0 58	0 59	1 1	1 2	1 4	15 24
3 36	0 52	0 54	0 55	0 57	0 58	1 0	1 1	1 3	1 4	1 6	1 7	15 36
3 48	0 55	0 57	0 59	1 0	1 2	1 3	1 5	1 6	1 8	1 10	1 11	15 48
4 0	0 58	1 0	1 2	1 3	1 5	1 7	1 8	1 10	1 12	1 13	1 15	16 0
4 12	1 1	1 3	1 6	1 6	1 8	1 10	1 12	1 13	1 15	1 17	1 19	16 12
4 24	1 4	1 6	1 8	1 10	1 11	1 13	1 15	1 17	1 19	1 21	1 22	16 24
4 36	1 7	1 9	1 11	1 13	1 15	1 17	1 19	1 20	1 22	1 24	1 26	16 36
4 48	1 10	1 12	1 14	1 16	1 18	1 20	1 22	1 24	1 26	1 28	1 30	16 48
5 0	1 13	1 15	1 17	1 19	1 21	1 23	1 25	1 27	1 30	1 32	1 34	17 0
5 12	1 16	1 18	1 20	1 22	1 24	1 27	1 29	1 31	1 33	1 35	1 37	17 12
5 24	1 19	1 21	1 23	1 25	1 28	1 30	1 32	1 34	1 37	1 39	1 41	17 24
5 36	1 22	1 24	1 26	1 29	1 31	1 33	1 36	1 38	1 40	1 43	1 45	17 36
5 48	1 25	1 27	1 29	1 32	1 34	1 37	1 39	1 41	1 44	1 46	1 49	17 48
6 0	1 27	1 30	1 32	1 35	1 37	1 40	1 42	1 45	1 47	1 50	1 52	18 0
6 12	1 30	1 33	1 36	1 38	1 41	1 43	1 46	1 48	1 51	1 54	1 56	18 12
6 24	1 33	1 36	1 39	1 41	1 44	1 47	1 49	1 52	1 55	1 57	2 0	18 24
6 36	1 36	1 39	1 42	1 44	1 47	1 50	1 53	1 55	1 58	2 1	2 4	18 36
6 48	1 39	1 42	1 45	1 48	1 50	1 53	1 56	1 59	2 2	2 5	2 7	18 48
7 0	1 42	1 45	1 48	1 51	1 54	1 57	2 0	2 2	2 5	2 8	2 11	19 0
7 12	1 45	1 48	1 51	1 54	1 57	2 0	2 3	2 6	2 9	2 12	2 15	19 12
7 24	1 48	1 51	1 54	1 57	2 0	2 3	2 6	2 9	2 13	2 16	2 19	19 24
7 36	1 51	1 54	1 57	2 0	2 3	2 7	2 10	2 13	2 16	2 19	2 22	19 36
7 48	1 54	1 57	2 0	2 3	2 7	2 10	2 13	2 16	2 20	2 23	2 26	19 48
8 0	1 57	2 0	2 3	2 7	2 10	2 13	2 17	2 20	2 23	2 27	2 30	20 0
8 12	2 0	2 3	2 6	2 10	2 13	2 17	2 20	2 23	2 27	2 30	2 34	20 12
8 24	2 2	2 6	2 9	2 13	2 16	2 20	2 23	2 27	2 30	2 34	2 37	20 24
8 36	2 5	2 9	2 13	2 16	2 20	2 23	2 27	2 30	2 34	2 38	2 41	20 36
8 48	2 8	2 12	2 16	2 19	2 23	2 27	2 30	2 34	2 38	2 41	2 45	20 48
9 0	2 11	2 15	2 19	2 22	2 26	2 30	2 34	2 37	2 41	2 45	2 49	21 0
9 12	2 14	2 18	2 22	2 26	2 29	2 33	2 37	2 41	2 45	2 49	2 52	21 12
9 24	2 17	2 21	2 25	2 29	2 33	2 37	2 41	2 44	2 48	2 52	2 56	21 24
9 36	2 20	2 24	2 23	2 32	2 36	2 40	2 44	2 48	2 52	2 56	3 0	21 36
9 48	2 23	2 27	2 31	2 35	2 39	2 43	2 47	2 51	2 56	3 0	3 4	21 48
10 0	2 26	2 30	2 34	2 38	2 42	2 47	2 51	2 55	2 59	3 3	3 7	22 0
10 12	2 29	2 33	2 37	2 41	2 46	2 50	2 54	2 58	3 3	3 7	3 11	22 12
10 24	2 32	2 36	2 40	2 45	2 49	2 53	2 58	3 2	3 6	3 11	3 15	22 24
10 36	2 35	2 39	2 43	2 48	2 52	2 57	3 1	3 5	3 10	3 14	3 19	22 36
10 48	2 37	2 42	2 46	2 51	2 55	3 0	3 4	3 9	3 13	3 18	3 22	22 48
11 0	2 40	2 45	2 50	2 54	2 59	3 3	3 8	3 12	3 17	3 22	3 26	23 0
11 12	2 43	2 48	2 53	2 57	3 2	3 7	3 11	3 16	3 21	3 25	3 30	23 12
11 24	2 46	2 51	2 56	3 0	3 5	3 10	3 15	3 19	3 24	3 29	3 34	23 24
11 36	2 49	2 54	2 59	3 4	3 8	3 13	3 18	3 23	3 28	3 33	3 37	23 36
11 48	2 52	2 57	3 2	3 7	3 12	3 17	3 22	3 26	3 31	3 36	3 41	23 48
12 0	2 55	3 0	3 5	3 10	3 15	3 20	3 25	3 30	3 35	3 40	3 45	24 0

TABLE XXXI.

For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other time under any other Meridian.

Time from Noon.	Daily Variation of the Sun's Right Ascension in Time.																		Ship's Long.
	′ 3	″ 30	′ 3	″ 32	′ 3	″ 34	′ 3	″ 36	′ 3	″ 38	′ 3	″ 40	′ 3	″ 42	′ 3	″ 44	′ 3	″ 46	
0h 0′	0′	0″	0′	0″	0′	0″	0′	0″	0′	0″	0′	0″	0′	0″	0′	0″	0′	0″	0°
0 12	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	0	2	3
0 24	0	3	0	4	0	4	0	4	0	4	0	4	0	4	0	4	0	4	6
0 36	0	5	0	5	0	5	0	5	0	5	0	5	0	6	0	6	0	6	9
0 48	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	7	0	8	12
1 0	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	0	9	15
1 12	0	10	0	11	0	11	0	11	0	11	0	11	0	11	0	11	0	11	18
1 24	0	12	0	12	0	12	0	13	0	13	0	13	0	13	0	13	0	13	21
1 36	0	14	0	14	0	14	0	14	0	15	0	15	0	15	0	15	0	15	24
1 48	0	16	0	16	0	16	0	16	0	16	0	16	0	17	0	17	0	17	27
2 0	0	17	0	18	0	18	0	18	0	18	0	18	0	18	0	19	0	19	30
2 12	0	19	0	19	0	20	0	20	0	20	0	20	0	20	0	21	0	21	33
2 24	0	21	0	21	0	21	0	22	0	22	0	22	0	22	0	22	0	23	36
2 36	0	23	0	23	0	23	0	23	0	24	0	24	0	24	0	24	0	24	39
2 48	0	24	0	25	0	25	0	25	0	25	0	26	0	26	0	26	0	26	42
3 0	0	26	0	26	0	27	0	27	0	27	0	27	0	28	0	28	0	28	45
3 12	0	28	0	28	0	29	0	29	0	29	0	29	0	30	0	30	0	30	48
3 24	0	30	0	30	0	30	0	31	0	31	0	31	0	31	0	32	0	32	51
3 36	0	31	0	32	0	32	0	32	0	33	0	33	0	33	0	34	0	34	54
3 48	0	33	0	34	0	34	0	34	0	35	0	35	0	35	0	35	0	36	57
4 0	0	35	0	35	0	36	0	36	0	36	0	37	0	37	0	37	0	38	60
4 12	0	37	0	37	0	37	0	38	0	38	0	38	[illegible]	39	0	39	0	40	63
4 24	0	38	0	39	0	39	0	40	0	40	0	40	0	41	0	41	0	41	66
4 36	0	40	0	41	0	41	0	41	0	42	0	42	0	43	0	43	0	43	69
4 48	0	42	0	42	0	43	0	43	0	44	0	44	0	44	0	45	0	45	72
5 0	0	44	0	44	0	45	0	45	0	45	0	46	0	46	0	47	0	47	75
5 12	0	45	0	46	0	46	0	47	0	47	0	48	0	48	0	49	0	49	78
5 24	0	47	0	48	0	48	0	49	0	49	0	49	0	50	0	50	0	51	81
5 36	0	49	0	49	0	50	0	50	0	51	0	51	0	52	0	52	0	53	84
5 48	0	51	0	51	0	52	0	52	0	53	0	53	0	54	0	54	0	55	87
6 0	0	52	0	53	0	53	0	54	0	54	0	55	0	55	0	56	0	56	90
6 12	0	54	0	55	0	55	0	56	0	56	0	57	0	57	0	58	0	58	93
6 24	0	56	0	57	0	57	0	58	0	58	0	59	0	59	1	0	1	0	96
6 36	0	58	0	58	0	59	0	59	1	0	1	0	1	1	1	2	1	2	99
6 48	0	59	1	0	1	1	1	1	1	2	1	2	1	3	1	3	1	4	102
7 0	1	1	1	2	1	2	1	3	1	4	1	4	1	5	1	5	1	6	105
7 12	1	3	1	4	1	4	1	5	1	5	1	6	1	7	1	7	1	8	108
7 24	1	5	1	5	1	6	1	7	1	7	1	8	1	8	1	9	1	10	111
7 36	1	6	1	7	1	8	1	8	1	9	1	10	1	10	1	11	1	12	114
7 48	1	8	1	9	1	10	1	10	1	11	1	11	1	12	1	13	1	13	117
8 0	1	10	1	11	1	11	1	12	1	13	1	13	1	14	1	15	1	15	120
8 12	1	12	1	12	1	13	1	14	1	14	1	15	1	16	1	17	1	17	123
8 24	1	13	1	14	1	15	1	16	1	16	1	17	1	18	1	18	1	19	126
8 36	1	15	1	16	1	17	1	17	1	18	1	19	1	20	1	20	1	21	129
8 48	1	17	1	18	1	18	1	19	1	20	1	21	1	21	1	22	1	23	132
9 0	1	19	1	19	1	20	1	21	1	22	1	22	1	23	1	24	1	25	135
9 12	1	20	1	21	1	22	1	23	1	24	1	24	1	25	1	26	1	27	138
9 24	1	22	1	23	1	24	1	25	1	25	1	26	1	27	1	28	1	29	141
9 36	1	24	1	25	1	26	1	26	1	27	1	28	1	29	1	30	1	30	144
9 48	1	26	1	27	1	27	1	28	1	29	1	30	1	31	1	31	1	32	147
10 0	1	27	1	28	1	29	1	30	1	31	1	32	1	32	1	33	1	34	150
10 12	1	29	1	30	1	31	1	32	1	33	1	33	1	34	1	35	1	36	153
10 24	1	31	1	32	1	33	1	34	1	34	1	35	1	36	1	37	1	38	156
10 36	1	33	1	34	1	35	1	35	1	36	1	37	1	38	1	39	1	40	159
10 48	1	34	1	35	1	36	1	37	1	38	1	39	1	40	1	41	1	42	162
11 0	1	36	1	37	1	38	1	39	1	40	1	41	1	42	1	43	1	44	165
11 12	1	38	1	39	1	40	1	41	1	42	1	43	1	44	1	45	1	45	168
11 24	1	40	1	41	1	42	1	43	1	44	1	44	1	45	1	46	1	47	171
11 36	1	41	1	42	1	43	1	44	1	45	1	46	1	47	1	48	1	49	174
11 48	1	43	1	44	1	45	1	46	1	47	1	48	1	49	1	50	1	51	177
12 0	1	45	1	46	1	47	1	48	1	49	1	50	1	51	1	52	1	53	180
	3′	30″	3′	32″	3′	34″	3′	36″	3′	38″	3′	40″	3′	42″	3′	44″	3′	46″	

TABLE XXXI.

For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other time under any other Meridian.

Time from Noon	Daily Variation of the Sun's Right Ascension in Time. ′ ″ 3 48	′ ″ 3 50	′ ″ 3 52	′ ″ 3 54	′ ″ 3 56	′ ″ 3 58	′ ″ 4 0	′ ″ 4 2	′ ″ 4 4	′ ″ 4 6	Ship's Long.
0h 0′	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0°
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	3
0 24	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	6
0 36	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 6	9
0 48	0 8	0 8	0 8	0 8	0 8	0 8	0 8	0 8	0 8	0 8	12
1 0	0 9	0 10	0 10	0 10	0 10	0 10	0 10	0 10	0 10	0 10	15
1 12	0 11	0 11	0 12	0 12	0 12	0 12	0 12	0 12	0 12	0 12	18
1 24	0 13	0 13	0 14	0 14	0 14	0 14	0 14	0 14	0 14	0 14	21
1 36	0 15	0 15	0 15	0 16	0 16	0 16	0 16	0 16	0 16	0 16	24
1 48	0 17	0 17	0 17	0 18	0 18	0 18	0 18	0 18	0 18	0 18	27
2 0	0 19	0 19	0 19	0 19	0 20	0 20	0 20	0 20	0 20	0 20	30
2 12	0 21	0 21	0 21	0 21	0 22	0 22	0 22	0 22	0 22	0 23	33
2 24	0 23	0 23	0 23	0 23	0 24	0 24	0 24	0 24	0 24	0 25	36
2 36	0 25	0 25	0 25	0 25	0 26	0 26	0 26	0 26	0 26	0 27	39
2 48	0 27	0 27	0 27	0 27	0 28	0 28	0 28	0 28	0 28	0 29	42
3 0	0 28	0 29	0 29	0 29	0 29	0 30	0 30	0 30	0 30	0 31	45
3 12	0 30	0 31	0 31	0 31	0 31	0 32	0 32	0 32	0 33	0 33	48
3 24	0 32	0 33	0 33	0 33	0 33	0 34	0 34	0 34	0 35	0 35	51
3 36	0 34	0 34	0 35	0 35	0 35	0 36	0 36	0 36	0 37	0 37	54
3 48	0 36	0 36	0 37	0 37	0 37	0 38	0 38	0 38	0 39	0 39	57
4 0	0 38	0 38	0 39	0 39	0 39	0 40	0 40	0 40	0 41	0 41	60
4 12	0 40	0 40	0 41	0 41	0 41	0 42	0 42	0 42	0 43	0 43	63
4 24	0 42	0 42	0 43	0 43	0 43	0 44	0 44	0 44	0 45	0 45	66
4 36	0 44	0 44	0 44	0 45	0 45	0 46	0 46	0 46	0 47	0 47	69
4 48	0 46	0 46	0 46	0 47	0 47	0 48	0 48	0 48	0 49	0 49	72
5 0	0 47	0 48	0 48	0 49	0 49	0 50	0 50	0 50	0 51	0 51	75
5 12	0 49	0 50	0 50	0 51	0 51	0 52	0 52	0 52	0 53	0 53	78
5 24	0 51	0 52	0 52	0 53	0 53	0 54	0 54	0 54	0 55	0 55	81
5 36	0 53	0 54	0 54	0 55	0 55	0 56	0 56	0 56	0 57	0 57	84
5 48	0 55	0 56	0 56	0 57	0 57	0 58	0 58	0 58	0 59	0 59	87
6 0	0 57	0 57	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 1	90
6 12	0 59	0 59	1 0	1 0	1 1	1 1	1 2	1 3	1 3	1 4	93
6 24	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 5	1 5	1 6	96
6 36	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 7	1 7	1 8	99
6 48	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 9	1 9	1 10	102
7 0	1 6	1 7	1 8	1 8	1 9	1 9	1 10	1 11	1 11	1 12	105
7 12	1 8	1 9	1 10	1 10	1 11	1 11	1 12	1 13	1 13	1 14	108
7 24	1 10	1 11	1 12	1 12	1 13	1 13	1 14	1 15	1 15	1 16	111
7 36	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 17	1 17	1 18	114
7 48	1 14	1 15	1 15	1 16	1 17	1 17	1 18	1 19	1 19	1 20	117
8 0	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 21	1 21	1 22	120
8 12	1 18	1 19	1 19	1 20	1 21	1 21	1 22	1 23	1 23	1 24	123
8 24	1 20	1 20	1 21	1 22	1 23	1 23	1 24	1 25	1 25	1 26	126
8 36	1 22	1 22	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	129
8 48	1 24	1 24	1 25	1 26	1 27	1 27	1 28	1 29	1 29	1 30	132
9 0	1 25	1 26	1 27	1 28	1 28	1 29	1 30	1 31	1 31	1 32	135
9 12	1 27	1 28	1 29	1 30	1 30	1 31	1 32	1 33	1 34	1 34	138
9 24	1 29	1 30	1 31	1 32	1 32	1 33	1 34	1 35	1 36	1 36	141
9 36	1 31	1 32	1 33	1 34	1 34	1 35	1 36	1 37	1 38	1 38	144
9 48	1 33	1 34	1 35	1 36	1 36	1 37	1 38	1 39	1 40	1 40	147
10 0	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 41	1 42	1 42	150
10 12	1 37	1 38	1 39	1 39	1 40	1 41	1 42	1 43	1 44	1 45	153
10 24	1 39	1 40	1 41	1 41	1 42	1 43	1 44	1 45	1 46	1 47	156
10 36	1 41	1 42	1 42	1 43	1 44	1 45	1 46	1 47	1 48	1 49	159
10 48	1 43	1 43	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	162
11 0	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	165
11 12	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 55	168
11 24	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	171
11 36	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	174
11 48	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	177
12 0	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	180
	3′ 48″	3′ 50″	3′ 52″	3′ 54″	3′ 56″	3′ 58″	4′ 0″	4′ 2″	4′ 4″	4′ 6″	

TABLE XXXI.

For reducing the Sun's Right Ascension in Time, as given in the Nautical Almanac for Noon at Greenwich, to any other time under any other Meridian.

Time from Noon.	Daily Variation of the Sun's Right Ascension in Time.											Ship's Long.
	′ ″ 4 8	′ ″ 4 10	′ ″ 4 12	′ ″ 4 14	′ ″ 4 16	′ ″ 4 18	′ ″ 4 20	′ ″ 4 22	′ ″ 4 24	′ ″ 4 26	′ ″ 4 28	
0h 0′	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0°
0 12	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	0 2	3
0 24	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	0 4	6
0 36	0 6	0 6	0 6	0 6	0 6	0 6	0 6	0 7	0 7	0 7	0 7	9
0 48	0 8	0 8	0 8	0 8	0 9	0 9	0 9	0 9	0 9	0 9	0 9	12
1 0	0 10	0 10	0 10	0 11	0 11	0 11	0 11	0 11	0 11	0 11	0 11	15
1 12	0 12	0 12	0 13	0 13	0 13	0 13	0 13	0 13	0 13	0 13	0 13	18
1 24	0 14	0 15	0 15	0 15	0 15	0 15	0 15	0 15	0 15	0 16	0 16	21
1 36	0 17	0 17	0 17	0 17	0 17	0 17	0 17	0 17	0 18	0 18	0 18	24
1 48	0 19	0 19	0 19	0 19	0 19	0 19	0 19	0 20	0 20	0 20	0 20	27
2 0	0 21	0 21	0 21	0 21	0 21	0 21	0 22	0 22	0 22	0 22	0 22	30
2 12	0 23	0 23	0 23	0 23	0 23	0 24	0 24	0 24	0 24	0 24	0 25	33
2 24	0 25	0 25	0 25	0 25	0 26	0 26	0 26	0 26	0 26	0 27	0 27	36
2 36	0 27	0 27	0 27	0 28	0 28	0 28	0 28	0 28	0 29	0 29	0 29	39
2 48	0 29	0 29	0 29	0 30	0 30	0 30	0 30	0 31	0 31	0 31	0 31	42
3 0	0 31	0 31	0 31	0 32	0 32	0 32	0 32	0 33	0 33	0 33	0 33	45
3 12	0 33	0 33	0 34	0 34	0 34	0 34	0 35	0 35	0 35	0 35	0 36	48
3 24	0 35	0 35	0 36	0 36	0 36	0 37	0 37	0 37	0 37	0 38	0 38	51
3 36	0 37	0 37	0 38	0 38	0 38	0 39	0 39	0 39	0 40	0 40	0 40	54
3 48	0 39	0 40	0 40	0 40	0 41	0 41	0 41	0 41	0 42	0 42	0 42	57
4 0	0 41	0 42	0 42	0 42	0 43	0 43	0 43	0 44	0 44	0 44	0 45	60
4 12	0 43	0 44	0 44	0 44	0 45	0 45	0 45	0 46	0 46	0 47	0 47	63
4 24	0 45	0 46	0 46	0 47	0 47	0 47	0 48	0 48	0 48	0 49	0 49	66
4 36	0 48	0 48	0 48	0 49	0 49	0 49	0 50	0 50	0 51	0 51	0 51	69
4 48	0 50	0 50	0 50	0 51	0 51	0 52	0 52	0 52	0 53	0 53	0 54	72
5 0	0 52	0 52	0 52	0 53	0 53	0 54	0 54	0 55	0 55	0 55	0 56	75
5 12	0 54	0 54	0 55	0 55	0 55	0 56	0 56	0 57	0 57	0 58	0 58	78
5 24	0 56	0 56	0 57	0 57	0 58	0 58	0 58	0 59	0 59	1 0	1 0	81
5 36	0 58	0 58	0 59	0 59	1 0	1 0	1 1	1 1	1 2	1 2	1 3	84
5 48	1 0	1 0	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 4	1 5	87
6 0	1 2	1 2	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 6	1 7	90
6 12	1 4	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 8	1 9	1 9	93
6 24	1 6	1 7	1 7	1 8	1 8	1 9	1 9	1 10	1 10	1 11	1 11	96
6 36	1 8	1 9	1 9	1 10	1 10	1 11	1 11	1 12	1 13	1 13	1 14	99
6 48	1 10	1 11	1 11	1 12	1 13	1 13	1 14	1 14	1 15	1 15	1 16	102
7 0	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 16	1 17	1 18	1 18	105
7 12	1 14	1 15	1 16	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 20	108
7 24	1 16	1 17	1 18	1 18	1 19	1 20	1 20	1 21	1 21	1 22	1 23	111
7 36	1 19	1 19	1 20	1 20	1 21	1 22	1 22	1 23	1 24	1 24	1 25	114
7 48	1 21	1 21	1 22	1 23	1 23	1 24	1 24	1 25	1 26	1 26	1 27	117
8 0	1 23	1 23	1 24	1 25	1 25	1 26	1 27	1 27	1 28	1 29	1 29	120
8 12	1 25	1 25	1 26	1 27	1 27	1 28	1 29	1 30	1 30	1 31	1 32	123
8 24	1 27	1 27	1 28	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	126
8 36	1 29	1 30	1 30	1 31	1 32	1 32	1 33	1 34	1 35	1 35	1 36	129
8 48	1 31	1 32	1 32	1 33	1 34	1 35	1 35	1 36	1 37	1 38	1 38	132
9 0	1 33	1 34	1 34	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 40	135
9 12	1 35	1 36	1 37	1 37	1 38	1 39	1 40	1 40	1 41	1 42	1 43	138
9 24	1 37	1 38	1 39	1 39	1 40	1 41	1 42	1 43	1 43	1 44	1 45	141
9 36	1 39	1 40	1 41	1 42	1 42	1 43	1 44	1 45	1 46	1 46	1 47	144
9 48	1 41	1 42	1 43	1 44	1 45	1 45	1 46	1 47	1 48	1 49	1 49	147
10 0	1 43	1 44	1 45	1 46	1 47	1 47	1 48	1 49	1 50	1 51	1 52	150
10 12	1 45	1 46	1 47	1 48	1 49	1 50	1 50	1 51	1 52	1 53	1 54	153
10 24	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 54	1 55	1 56	156
10 36	1 50	1 50	1 51	1 52	1 53	1 54	1 55	1 56	1 57	1 57	1 58	159
10 48	1 52	1 52	1 53	1 54	1 55	1 56	1 57	1 58	1 59	2 0	2 1	162
11 0	1 54	1 55	1 55	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	165
11 12	1 56	1 57	1 58	1 59	1 59	2 0	2 1	2 2	2 3	2 4	2 5	168
11 24	1 58	1 59	2 0	2 1	2 2	2 3	2 3	2 4	2 5	2 6	2 7	171
11 36	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	174
11 48	2 2	2 3	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	177
12 0	2 4	2 5	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 13	2 14	180
	4′ 8″	4′ 10″	4′ 12″	4′ 14″	4′ 16″	4′ 18″	4′ 20″	4′ 22″	4′ 24″	4′ 26″	4′ 28″	

TABLE XXXII.

Variation of the Sun's Altitude in one minute from noon.

Lat.	Declination of a different name from the latitude.												Lat.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
	″	″	″	″	″	″	″	″	″	″	″	″	
0°					28.1	22.4	18.7	16.0	14.0	12.4	11.1	10.1	0°
1				28.1	22.4	18.7	16.0	14.0	12.4	11.2	10.1	9.3	1
2			28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	2
3		28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	3
4	28.1	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.4	4
5	22.4	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.4	7.0	5
6	18.7	16.0	14.0	12.5	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6
7	16.0	14.0	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	7
8	14.0	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	8
9	12.4	11.2	10.2	9.3	8.6	8.0	7.5	7.0	6.6	6.2	5.9	5.6	9
10	11.1	10.1	9.3	8.6	8.0	7.4	7.0	6.6	6.2	5.9	5.6	5.3	10
11	10.1	9.3	8.6	8.0	7.4	7.0	6.6	6.2	5.9	5.6	5.3	5.1	11
12	9.2	8.5	7.9	7.4	7.0	6.5	6.2	5.9	5.6	5.3	5.0	4.8	12
13	8.5	7.9	7.4	6.9	6.5	6.2	5.8	5.6	5.3	5.0	4.8	4.6	13
14	7.9	7.4	6.9	6.5	6.2	5.8	5.5	5.3	5.0	4.8	4.6	4.4	14
15	7.3	6.9	6.5	6.1	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.2	15
16	6.8	6.5	6.1	5.8	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	16
17	6.4	6.1	5.8	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	3.9	17
18	6.0	5.7	5.5	5.2	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	18
19	5.7	5.4	5.2	4.9	4.7	4.5	4.4	4.2	4.0	3.9	3.8	3.6	19
20	5.4	5.1	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.8	3.6	3.5	20
21	5.1	4.9	4.7	4.5	4.3	4.2	4.0	3.9	3.7	3.6	3.5	3.4	21
22	4.9	4.7	4.5	4.3	4.1	4.0	3.9	3.7	3.6	3.5	3.4	3.3	22
23	4.6	4.4	4.3	4.1	4.0	3.8	3.7	3.6	3.5	3.4	3.3	3.2	23
24	4.4	4.2	4.1	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	24
25	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.1	3.0	25
26	4.0	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	3.0	3.0	2.9	26
27	3.9	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	27
28	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	28
29	3.5	3.4	3.3	3.2	3.1	3.1	3.0	2.9	2.8	2.8	2.7	2.6	29
30	3.4	3.3	3.2	3.1	3.0	3.0	2.9	2.8	2.7	2.7	2.6	2.5	30
31	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.5	31
32	3.1	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4	32
33	3.0	2.9	2.9	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	33
34	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.3	34
35	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	35
36	2.7	2.6	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	36
37	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.2	2.1	2.1	37
38	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	38
39	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	2.0	39
40	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	40
41	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	41
42	2.2	2.1	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	42
43	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	43
44	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	44
45	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	45
46	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	46
47	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	47
48	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.5	1.5	48
49	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	49
50	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	50
52	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	52
54	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	54
56	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	56
58	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	58
60	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	60
62	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	62
64	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	64
66	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	66
68	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	68
70	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	70
	0	1	2	3	4	5	6	7	8	9	10	11	

TABLE XXXII.

Variation of the Sun's Altitude in one minute from noon.

	Declination of a different name from the Latitude.													
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	
Lat.	″	″	″	″	″	″	″	″	″	″	″	″	″	Lat.
0	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.9	4.6	4.4	0
1	8.5	7.9	7.4	6.9	6.5	6.1	5.7	5.4	5.1	4.9	4.7	4.4	4.2	1
2	7.9	7.4	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.7	4.5	4.3	4.1	2
3	7.4	6.9	6.5	6.1	5.8	5.5	5.2	4.9	4.7	4.5	4.3	4.1	3.9	3
4	7.0	6.5	6.2	5.8	5.5	5.2	5.0	4.7	4.5	4.3	4.1	4.0	3.8	4
5	6.5	6.2	5.8	5.5	5.2	5.0	4.8	4.5	4.3	4.2	4.0	3.8	3.7	5
6	6.2	5.8	5.5	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	6
7	5.9	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	3.5	7
8	5.6	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.6	3.5	3.4	8
9	5.3	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	9
10	5.0	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	10
11	4.8	4.6	4.4	4.2	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	11
12	4.6	4.4	4.3	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	12
13	4.4	4.3	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	13
14	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	14
15	4.1	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	15
16	3.9	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	16
17	3.8	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	17
18	3.7	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.5	18
19	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	19
20	3.4	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.4	20
21	3.3	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	21
22	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	22
23	3.1	3.0	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.3	23
24	3.0	2.9	2.8	2.8	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	24
25	2.9	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	25
26	2.8	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.1	2.1	26
27	2.7	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.2	2.2	2.1	2.1	2.1	27
28	2.6	2.6	2.5	2.5	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.0	28
29	2.6	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	29
30	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	30
31	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	31
32	2.3	2.3	2.2	2.2	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	32
33	2.3	2.2	2.2	2.1	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	33
34	2.2	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	34
35	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.7	1.7	35
36	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	36
37	2.0	2.0	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	37
38	2.0	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	38
39	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	39
40	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	40
41	1.8	1.8	1.8	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	41
42	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	42
43	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	43
44	1.7	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	44
45	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	45
46	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	46
47	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	47
48	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	48
49	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	49
50	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	50
52	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	52
54	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	54
56	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	56
58	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	58
60	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	60
62	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	62
64	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	64
66	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7		66
68	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7				68
70	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6						70
	12	13	14	15	16	17	18	19	20	21	22	23	24	

TABLE XXXII.

Variation of the Sun's Altitude in one minute from noon.

Lat.	Declination of the same name as the latitude.												Lat.
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	
	"	"	"	"	"	"	"	"	"	"	"	"	
0°					28.1	22.4	18.7	16.0	14.0	12.4	11.1	10.1	0°
1						28.0	22.4	18.6	16.0	13.9	12.4	11.1	1
2							28.0	22.3	18.6	15.9	13.9	12.3	2
3								27.9	22.3	18.5	15.8	13.8	3
4	28.1								27.8	22.2	18.5	15.8	4
5	22.4	28.0								27.7	22.1	18.4	5
6	18.7	22.4	28.0								27.6	22.0	6
7	16.0	18.6	22.3	27.9								27.4	7
8	14.0	16.0	18.6	22.3	27.8								8
9	12.4	13.9	15.9	18.5	22.2	27.7							9
10	11.1	12.4	13.9	15.8	18.5	22.1	27.6						10
11	10.1	11.1	12.3	13.8	15.8	18.4	22.0	27.4					11
12	9.2	10.1	11.1	12.3	13.8	15.7	18.3	21.9	27.3				12
13	8.5	9.2	10.0	11.0	12.2	13.7	15.6	18.2	21.7	27.1			13
14	7.9	8.5	9.2	10.0	10.9	12.1	13.6	15.5	18.0	21.6	26.9		14
15	7.3	7.8	8.4	9.1	9.9	10.9	12.1	13.5	15.4	17.9	21 4	26.7	15
16	6.8	7.3	7.8	8.4	9.1	9.8	10.8	12.0	13.4	15.3	17.6	21.3	16
17	6.4	6.8	7.2	7.8	8.3	9.0	9.8	10.7	11.9	13.3	15 2	17.6	17
18	6.0	6.4	6.8	7.2	7.7	8.3	8.9	9.7	10.6	11.8	13.2	15.0	18
19	5.7	6.0	6.3	6.7	7.2	7.6	8.2	8.9	9.6	10.6	11.7	13.1	19
20	5.4	5.7	6.0	6.3	6.7	7.1	7.6	8.1	8.8	9.5	10.5	11.6	20
21	5.1	5.4	5.6	5.9	6.3	6.6	7.0	7.5	8.1	8.7	9.5	10.4	21
22	4.9	5.1	5.3	5.6	5.9	6.2	6.6	7.0	7.5	8.0	8 6	9.4	22
23	4.6	4.8	5.0	5.3	5.5	5.8	6.1	6.5	6.9	7.4	7.9	8.5	23
24	4.4	4.6	4.8	5.0	5.2	5.5	5.8	6.1	6.4	6.8	7.3	7.8	24
25	4.2	4.4	4.6	4.7	5.0	5.2	5.4	5.7	6.0	6.4	6.8	7.2	25
26	4.0	4.2	4.3	4.5	4.7	4.9	5.1	5.4	5.7	6.0	6.3	6.7	26
27	3.9	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.6	5.9	6.2	27
28	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.8	5.0	5.3	5.5	5.8	28
29	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.6	4.7	5.0	5.2	5.5	29
30	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	4.5	4.7	4.9	5.1	30
31	3.3	3.4	3.5	3.6	3.7	3.8	4.0	4.1	4.3	4.4	4.6	4.8	31
32	3.1	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.6	32
33	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	33
34	2.9	3.0	3.1	3.2	3.2	3.3	3.4	3.6	3.7	3.8	3.9	4.1	34
35	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	35
36	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	36
37	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	37
38	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.0	3.2	3.2	3.3	38
39	2.4	2.5	2.5	2.6	2.7	2.7	2.8	2.9	2.9	3.0	3.1	3.2	39
40	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.7	2.8	2.9	3.0	3.0	40
41	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	2.8	2.9	41
42	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.8	42
43	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.7	43
44	2.0	2.1	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5	44
45	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.3	2.3	2.4	2.4	45
46	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.2	2.3	2.3	46
47	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.2	2.2	47
48	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1	2.1	48
49	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	49
50	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	2.0	50
52	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	52
54	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	54
56	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	56
58	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	58
60	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	60
62	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	62
64	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	64
66	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	66
68	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	68
70	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	70
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	

TABLE XXXII.

Variation of the Sun's Altitude in one minute from noon.

Lat.	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	Lat.
	Declination of the same name as the Latitude.													
	"	"	"	"	"	"	"	"	"	"	"	"	"	
0°	9.2	8.5	7.9	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.9	4.6	4.4	0°
1	10.1	9.2	8.5	7.8	7.3	6.8	6.4	6.0	5.7	5.4	5.1	4.8	4.6	1
2	11.1	10.0	9.2	8.4	7.8	7.2	6.8	6.3	6.0	5.6	5.3	5.0	4.8	2
3	12.3	11.0	10.0	9.1	8.4	7.8	7.2	6.7	6.3	5.9	5.6	5.3	5.0	3
4	13.8	12.2	10.9	9.9	9.1	8.3	7.7	7.2	6.7	6.3	5.9	5.5	5.2	4
5	15.7	13.7	12.1	10.9	9.8	9.0	8.3	7.6	7.1	6.6	6.2	5.8	5.5	5
6	18.3	15.6	13.6	12.1	10.8	9.8	8.9	8.2	7.6	7.0	6.6	6.1	5.8	6
7	21.9	18.2	15.5	13.5	12.0	10.7	9.7	8.9	8.1	7.5	7.0	6.5	6.1	7
8	27.3	21.7	18.0	15.4	13.4	11.9	10.6	9.6	8.8	8.1	7.5	6.9	6.4	8
9		27.1	21.6	17.9	15.3	13.3	11.8	10.6	9.5	8.7	8.0	7.4	6.8	9
10			26.9	21.4	17.8	15.2	13.2	11.7	10.5	9.5	8.6	7.9	7.3	10
11				26.7	21.3	17.6	15.0	13.1	11.6	10.4	9.4	8.5	7.8	11
12					26.5	21.1	17.5	14.9	13.0	11.5	10.3	9.3	8.4	12
13						26.2	20.9	17.3	14.8	12.8	11.3	10.1	9.2	13
14							26.0	20.7	17.1	14.6	12.7	11.2	10.0	14
15								25.7	20.4	16.9	14.4	12.5	11.1	15
16	26.5								25.4	20.2	16.7	14.3	12.4	16
17	21.1	26.2								25.1	20.0	16.5	14.1	17
18	17.5	20.9	26.0								24.8	19.7	16.3	18
19	14.9	17.3	20.7	25.7								24.5	19.5	19
20	13.0	14.8	17.1	20.4	25.4								24.2	20
21	11.5	12.8	14.6	16.9	20.2	25.1								21
22	10.3	11.3	12.7	14.4	16.7	20.0	24.8							22
23	9.3	10.1	11.2	12.5	14.3	16.5	19.7	24.5						23
24	8.4	9.2	10.0	11.1	12.4	14.1	16.3	19.5	24.2					24
25	7.7	8.3	9.0	9.9	10.9	12.2	13.9	16.1	19.2	23.8				25
26	7.1	7.6	8.2	8.9	9.8	10.8	12.1	13.7	15.9	18.9	23.5			26
27	6.6	7.0	7.5	8.1	8.8	9.6	10.6	11.9	13.5	15.6	18.6	23.1		27
28	6.2	6.5	7.0	7.4	8.0	8.7	9.5	10.5	11.7	13.3	15.4	18.3	22.7	28
29	5.7	6.1	6.4	6.9	7.3	7.9	8.6	9.4	10.3	11.5	13.1	15.1	18.0	29
30	5.4	5.7	6.0	6.4	6.8	7.2	7.8	8.4	9.2	10.1	11.3	12.8	14.9	30
31	5.1	5.3	5.6	5.9	6.3	6.7	7.1	7.7	8.3	9.0	10.0	11.1	12.6	31
32	4.8	5.0	5.2	5.5	5.8	6.2	6.5	7.0	7.5	8.1	8.9	9.8	10.9	32
33	4.5	4.7	4.9	5.1	5.4	5.7	6.1	6.4	6.9	7.4	8.0	8.7	9.6	33
34	4.3	4.4	4.6	4.8	5.1	5.3	5.6	5.9	6.3	6.8	7.3	7.8	8.6	34
35	4.0	4.2	4.4	4.5	4.7	5.0	5.2	5.5	5.8	6.2	6.6	7.1	7.7	35
36	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.1	5.4	5.7	6.1	6.5	7.0	36
37	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.0	5.3	5.6	6.0	6.4	37
38	3.4	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	4.9	5.2	5.5	5.8	38
39	3.3	3.4	3.5	3.6	3.8	3.9	4.0	4.2	4.4	4.6	4.8	5.1	5.4	39
40	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.3	4.5	4.7	5.0	40
41	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.4	4.6	41
42	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.7	3.8	4.0	4.1	4.3	42
43	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.5	3.6	3.7	3.9	4.0	43
44	2.6	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.8	44
45	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	45
46	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	46
47	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	2.9	3.0	3.1	47
48	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	48
49	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	2.7	2.8	49
50	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.6	2.6	50
52	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.3	2.4	52
54	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.1	2.1	54
56	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.9	56
58	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7	58
60	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	60
62	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.4	62
64	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	64
66	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	66
68	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	68
70	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	70
	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	

TABLE XXXIII.

To reduce the numbers of Table XXXII. to other given intervals of time from noon.

Time from Noon.

S.	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	S.
0	0.0	1.0	4.0	9.0	16.0	25.0	36.0	49.0	64.0	81.0	100.0	121.0	144.0	0
1	0.0	1.0	4.1	9.1	16.1	25.2	36.2	49.2	64.3	81.3	100.3	121.4	144.4	1
2	0.0	1.1	4.1	9.2	16.3	25.3	36.4	49.5	64.5	81.6	100.7	121.7	144.8	2
3	0.0	1.1	4.2	9.3	16.4	25.5	36.6	49.7	64.8	81.9	101.0	122.1	145.2	3
4	0.0	1.1	4.3	9.4	16.5	25.7	36.8	49.9	65.1	82.2	101.3	122.5	145.6	4
5	0.0	1.2	4.3	9.5	16.7	25.8	37.0	50.2	65.3	82.5	101.7	122.9	146.0	5
6	0.0	1.2	4.4	9.6	16.8	26.0	37.2	50.4	65.6	82.8	102.0	123.2	146.4	6
7	0.0	1.2	4.5	9.7	16.9	26.2	37.4	50.6	65.9	83.1	102.3	123.6	146.8	7
8	0.0	1.3	4.6	9.8	17.1	26.4	37.6	50.9	66.1	83.4	102.7	124.0	147.2	8
9	0.0	1.3	4.6	9.9	17.2	26.5	37.8	51.1	66.4	83.7	103.0	124.3	147.6	9
10	0.0	1.4	4.7	10.0	17.4	26.7	38.0	51.4	66.7	84.0	103.4	124.7	148.0	10
11	0.0	1.4	4.8	10.1	17.5	26.9	38.2	51.6	67.0	84.3	103.7	125.1	148.4	11
12	0.0	1.4	4.8	10.2	17.6	27.0	38.4	51.8	67.2	84.6	104.0	125.4	148.8	12
13	0.0	1.5	4.9	10.3	17.8	27.2	38.6	52.1	67.5	84.9	104.4	125.8	149.2	13
14	0.1	1.5	5.0	10.5	17.9	27.4	38.9	52.3	67.8	85.3	104.7	126.2	149.7	14
15	0.1	1.6	5.1	10.6	18.1	27.6	39.1	52.6	68.1	85.6	105.1	126.6	150.1	15
16	0.1	1.6	5.1	10.7	18.2	27.7	39.3	52.8	68.3	85.9	105.4	126.9	150.5	16
17	0.1	1.6	5.2	10.8	18.3	27.9	39.5	53.0	68.6	86.2	105.7	127.3	150.9	17
18	0.1	1.7	5.3	10.9	18.5	28.1	39.7	53.3	68.8	86.5	106.1	127.7	151.3	18
19	0.1	1.7	5.4	11.0	18.6	28.3	39.9	53.5	69.2	86.8	106.4	128.1	151.7	19
20	0.1	1.8	5.4	11.1	18.8	28.4	40.1	53.8	69.4	87.1	106.8	128.4	152.1	20
21	0.1	1.8	5.5	11.2	18.9	28.6	40.3	54.0	69.7	87.4	107.1	128.8	152.5	21
22	0.1	1.9	5.6	11.3	19.1	28.8	40.5	54.3	70.0	87.7	107.5	129.2	152.9	22
23	0.1	1.9	5.7	11.4	19.2	29.0	40.7	54.5	70.3	88.0	107.8	129.6	153.3	23
24	0.2	2.0	5.8	11.6	19.4	29.2	41.0	54.8	70.6	88.4	108.2	130.0	153.8	24
25	0.2	2.0	5.8	11.7	19.5	29.3	41.2	55.0	70.8	88.7	108.5	130.3	154.2	25
26	0.2	2.1	5.9	11.8	19.7	29.5	41.4	55.3	71.1	89.0	108.9	130.7	154.6	26
27	0.2	2.1	6.0	11.9	19.8	29.7	41.6	55.5	71.4	89.3	109.2	131.1	155.0	27
28	0.2	2.2	6.1	12.0	20.0	29.9	41.8	55.8	71.7	89.6	109.6	131.5	155.4	28
29	0.2	2.2	6.2	12.1	20.1	30.1	42.0	56.0	72.0	89.9	109.9	131.9	155.8	29
30	0.2	2.2	6.2	12.2	20.2	30.2	42.2	56.2	72.2	90.2	110.2	132.2	156.2	30
31	0.3	2.3	6.3	12.4	20.4	30.4	42.5	56.5	72.5	90.6	110.6	132.6	156.7	31
32	0.3	2.4	6.4	12.5	20.6	30.6	42.7	56.8	72.8	90.9	111.0	133.0	157.1	32
33	0.3	2.4	6.5	12.6	20.7	30.8	42.9	57.0	73.1	91.2	111.3	133.4	157.5	33
34	0.3	2.5	6.6	12.7	20.9	31.0	43.1	57.3	73.4	91.5	111.7	133.8	157.9	34
35	0.3	2.5	6.7	12.8	21.0	31.2	43.3	57.5	73.7	91.8	112.0	134.2	158.3	35
36	0.4	2.6	6.8	13.0	21.2	31.4	43.6	57.8	74.0	92.2	112.4	134.6	158.8	36
37	0.4	2.6	6.8	13.1	21.3	31.5	43.8	58.0	74.3	92.5	112.7	134.9	159.2	37
38	0.4	2.7	6.9	13.2	21.5	31.7	44.0	58.2	74.5	92.8	113.1	135.3	159.6	38
39	0.4	2.7	7.0	13.3	21.6	31.9	44.2	58.5	74.8	93.1	113.4	135.7	160.0	39
40	0.4	2.8	7.1	13.4	21.8	32.1	44.4	58.8	75.1	93.4	113.8	136.1	160.4	40
41	0.5	2.8	7.2	13.6	21.9	32.3	44.7	59.0	75.4	93.8	114.1	136.5	160.9	41
42	0.5	2.9	7.3	13.7	22.1	32.5	44.9	59.3	75.7	94.1	114.5	136.9	161.3	42
43	0.5	2.9	7.4	13.8	22.2	32.7	45.1	59.5	76.0	94.4	114.8	137.3	161.7	43
44	0.5	3.0	7.5	13.9	22.4	32.9	45.3	59.8	76.3	94.7	115.2	137.7	162.1	44
45	0.6	3.1	7.6	14.1	22.6	33.1	45.6	60.1	76.6	95.1	115.6	138.1	162.6	45
46	0.6	3.1	7.7	14.2	22.7	33.3	45.8	60.3	76.9	95.4	115.9	138.5	163.0	46
47	0.6	3.2	7.7	14.3	22.9	33.4	46.0	60.6	77.1	95.7	116.3	138.8	163.4	47
48	0.6	3.2	7.8	14.4	23.0	33.6	46.2	60.8	77.4	96.0	116.6	139.2	163.8	48
49	0.7	3.3	7.9	14.6	23.2	33.8	46.5	61.1	77.7	96.4	117.0	139.6	164.3	49
50	0.7	3.4	8.0	14.7	23.4	34.0	46.7	61.4	78.0	96.7	117.4	140.0	164.7	50
51	0.7	3.4	8.1	14.8	23.5	34.2	46.9	61.6	78.3	97.0	117.7	140.4	165.1	51
52	0.8	3.5	8.2	15.0	23.7	34.4	47.2	61.9	78.6	97.4	118.1	140.8	165.6	52
53	0.8	3.5	8.3	15.1	23.8	34.6	47.4	62.1	78.9	97.7	118.4	141.2	166.0	53
54	0.8	3.6	8.4	15.2	24.0	34.8	47.6	62.4	79.2	98.0	118.8	141.6	166.4	54
55	0.8	3.7	8.5	15.3	24.2	35.0	47.8	62.7	79.5	98.3	119.2	142.0	166.8	55
56	0.9	3.7	8.6	15.5	24.3	35.2	48.1	62.9	79.8	98.7	119.5	142.4	167.3	56
57	0.9	3.8	8.7	15.6	24.5	35.4	48.3	63.2	80.1	99.0	119.9	142.8	167.7	57
58	0.9	3.9	8.8	15.7	24.7	35.6	48.5	63.5	80.4	99.3	120.3	143.2	168.1	58
59	1.0	3.9	8.9	15.9	24.8	35.8	48.8	63.7	80.7	99.7	120.6	143.6	168.6	59
	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′	

TABLE XXXIV.

Errors arising from a deviation of 1′ in the parallelism of the surfaces of the central mirror.

Obs'd. Angle.	Obs. to right.	Obs. to left.	Obs. cross	Fifth col.
D	′ ″	′ ″	′ ″	′ ″
0	0	0	0	0
10	2	1	2	0
20	5	2	4	2
30	10	1	6	4
40	16	0	8	7
45	19	1	9	9
50	23	2	11	11
55	28	4	12	14
60	33	5	14	17
65	39	7	16	21
70	46	10	18	25
75	54	12	21	30
80	1. 4	16	24	35
85	1.15	19	28	41
90	1.27	23	32	48
95	1.43	28	37	56
100	2. 1	33	44	1. 6
105	2.23	39	52	1.16
110	2.49	46	1. 1	1.29
115	3.23	54	1.14	1.44
120	4.05	1. 4	1.30	2. 3
130				2.51
140				4. 6

TABLE XXXV.

Angles Obs'd.	Angle of deviation.										
	10′	15′	20′	25′	30′	35′	40′	45′	50′	55′	60′
D	″	″	″	″	″	″	″	″	″	″	″
0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	2	2	3	4	5	5
20	0	1	1	2	3	4	5	6	8	9	11
30	0	1	2	3	4	6	7	9	12	14	17
40	1	1	3	4	6	8	10	13	16	19	23
50	1	2	3	5	7	10	13	16	20	25	29
60	1	2	4	6	9	12	16	20	25	30	36
65	1	3	4	7	10	14	18	23	28	34	40
70	1	3	5	8	11	15	20	25	31	37	44
75	1	3	5	8	12	16	21	27	33	41	48
80	1	3	6	9	13	18	23	30	37	44	53
85	2	4	6	10	14	20	26	32	40	48	58
90	2	4	7	11	16	21	28	35	44	53	63
95	2	4	8	12	17	23	30	39	48	58	69
100	2	5	8	13	19	25	33	42	52	63	75
105	2	5	9	14	20	28	36	46	57	69	82
110	2	6	10	16	22	31	40	50	62	75	90
115	3	6	11	17	25	34	44	55	68	83	99
120	3	7	12	19	27	37	48	61	76	91	109

TABLE XXXVI.

Corrections of the mean Refraction for various heights of the Thermometer and Barometer.

Ht. Th.	20°	24°	28°	32°	36°	40°	44°	48°	52°	56°	60°	64°	68°	72°	76°
Barom.	32.00	31.66	31.32	30.99	30.67	30.36	30.05	29.75	29.45	29.16	28.88	28.60	28.33	28.06	
app. alt.	′+″	′+″	′+″	′+″	′+″	′+″	′+″	′+″	′−″	′−″	′−″	′−″	′−″	′−″	′−″
° ′															
0 0	2 41	2 18	1 55	1 33	1 12	51	30	10	10	29	48	1 7	1 25	1 43	2 1
0 30	2 18	1 58	1 39	1 20	1 2	44	26	9	8	25	41	58	1 13	1 29	1 44
1 0	1 59	1 42	1 26	1 9	53	38	22	7	7	22	36	50	1 3	1 17	1 30
1 30	1 43	1 29	1 14	1 0	46	33	19	6	6	19	31	43	55	1 6	1 18
2 0	1 30	1 18	1 5	0 53	40	29	17	6	6	16	27	37	48	58	1 8
2 30	1 20	1 8	57	46	36	25	15	5	5	15	24	33	43	51	1 0
3 0	1 11	1 1	51	41	32	22	13	4	4	13	21	30	38	46	53
4	58	49	41	33	26	18	11	4	4	10	17	24	31	37	43
5	48	41	35	28	22	15	9	3	3	9	14	20	26	31	36
6	41	35	30	24	18	13	8	3	3	7	12	17	22	26	31
7	36	31	26	21	16	11	7	2	2	7	11	15	19	23	27
8	32	27	23	18	14	10	6	2	2	6	10	13	17	20	24
9	28	24	20	16	13	9	5	2	2	5	9	12	15	18	21
10	26	22	18	15	11	8	5	2	2	5	8	10	14	16	19
12	21	18	15	12	10	7	4	1	1	4	6	9	11	14	16
14	18	16	13	11	8	6	5	1	1	3	6	8	10	12	14
16	16	14	11	9	7	5	3	1	1	3	5	7	9	10	12
18	14	12	10	8	6	4	3	1	1	3	4	6	7	9	11
21	12	10	9	7	5	4	2	1	1	2	4	5	6	8	9
24	10	9	7	6	5	3	2	1	1	2	3	4	5	7	8
27	9	8	6	5	4	3	2	1	1	2	3	4	5	6	7
30	8	7	6	5	4	3	1	0	0	1	2	3	4	5	6
35	7	6	5	4	3	2	1	0	0	1	2	3	3	4	5
40	6	5	4	3	2	2	1	0	0	1	2	2	3	4	4
45	5	4	3	3	2	1	1	0	0	1	1	2	2	3	3
50	4	3	3	2	2	1	1	0	0	1	1	2	2	3	3
60	3	2	2	2	1	1	1	0	0	0	1	1	1	2	2
70	2	1	1	1	1	1	0	0	0	0	1	1	1	1	1
80	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE XXXVII.
Longitudes and Latitudes of Stars, for Jan. 1, 1820.

Names of Stars.	Mag.	Longitude.	Ann. Var. aft. 1820.	Latitude.	Ann. Var. aft. 1820.
		s ° ′ ″	″	° ′ ″	″
γ Pegasi....... *Algenib*	2	0. 6.38.48	50.09	12.35.42 N.	+0.12
α Andromedæ .. *Alpheratz*	2	0.11.48. 6	49.98	25.41. 7 N.	+0.16
η Piscium	4.3	0.24.18.10	50.16	5.22. 2 N.	+0.25
α Arietis	2.3	1. 5. 8.44	50.27	9.57.38 N.	+0.16
α Ceti......... *Menkar*...............	2	1.11.48.18	50.27	12.35.44 S.	−0.37
η Pleiadum..... *Alcyone*..............	3	1.27.28.35	50.18	4. 2. 3 N.	+0.43
γ Tauri	3	2. 3.16.52	50.21	5.45. 1 S.	−0.45
ε Tauri	3.4	2. 5.56.33	50.20	2.35. 6 S.	−0.46
α Tauri........ Aldebaran	1	2. 7.16.23	50.21	5.28.44 S.	−0.33
β Orionis....... *Rigel*	1	2.14.18.45	50.24	31. 8.44 S.	−0.47
α Aurigæ....... *Capella*	1	2.19.20.25	50.19	22.52.12 N.	+0.48
δ Orionis	2	2.19.50.55	50.20	23.34.34 S.	−0.48
β Tauri	2	2.20. 3.36	50.20	5.22.26 N.	+0.48
ε Orionis.............................	2	2.20.57. 1	50.20	24.31.43 S.	−0.48
ζ Orionis.............................	2	2.22.10. 4	50.20	25.18.56 S.	−0.48
ζ Tauri	3	2.22.16.10	50.20	2.13. 0 S.	−0.48
α Orionis....... *Betelguese*	1	2.26.14.20	50.19	16. 3. 4 S.	−0.48
η Geminorum	3.4	3. 0.55.32	50.20	0.54.33 S.	−0.48
μ Geminorum	3	3. 2.46.52	50.20	0.50. 4 S.	−0.47
γ Geminorum	2.3	3. 6.35.13	50.18	6.45.41 S.	−0.47
ε Geminorum	3	3. 7.25.24	50 20	2. 2.55 N.	+0.46
α Canis Majoris *Sirius*...............	1	3.11.36.34	50.07	39.22.31 S.	−0.45
ζ Geminorum	3.4	3.12.28.30	50.19	2. 3.36 S.	−0.45
δ Geminorum	3	3.16. 0.21	50.20	0.11.54 S.	−0.44
α Geminorum .. *Castor*	1.2	3.17.44. 2	50.23	10. 5. 0 N.	+0.43
β Geminorum .. Pollux	2	3.20.43.51	49.50	6.40.17 N.	+0.26
α Canis Minoris *Procyon*..............	1.2	3.23.18.48	50.12	15.57.47 S.	−0.41
α 2 Cancri...... *Acubens*..............	4.3	4.11. 7 30	50.16	5. 5.38 S.	−0.31
α Hydræ....... *Alphard*	2	4.24.46.30	50.02	22.23.38 S.	−0.22
η Leonis..............................	3.4	4.25.23.18	50.23	4.51.19 N.	+0.22
α Leonis....... Regulus..............	1	4.27.19.34	49.94	0.27.39 N	+0.22
β Leonis....... *Denebola*..............	1.2	5.19. 7.31	50.30	12 17.10 N.	+0.03
β Virginis	3	5.24.35.54	50.20	0.41.32 N.	−0.02
η Virginis............................	4.3	6. 2.19.20	50.21	1.22.23 N.	−0.08
γ Virginis	3	6. 7.39.42	50.00	2.48.43 N.	−0.13
α Virginis ...... Spica...............	1	6.21.19.44	50.08	2. 2.20 S.	+0.17
α Bootis ...... *Arcturus*	1	6.21.43.30	50.45	30.54. 0 N.	−0.24
α Coronæ Bor.... *Alphacca*	2.3	7. 9.45. 7	50.51	44.20.46 N.	−0.35
α 2 Libræ...... *Zubenesch*.............	2.3	7.12.34.26	50.20	0.21.29 N.	−0.37
α Serpentis	2.3	7.19.32.45	50.32	25.31.31 N.	−0.40
γ Libræ	3.4	7.22.37. 5	50.22	4.24.24 N.	−0.42
δ Scorpii	2.3	7.28.36.38	50.18	5.27.45 S.	+0.44
β Scorpii	3.2	8. 0. 3.22	50.19	1.57.38 S.	+0.44
π Scorpii	3	8. 0.25.27	50.18	5.26.59 S.	+0.45
β Scorpii	2	8. 0.40.27	50.20	1. 1.57 N.	−0.45
α Scorpii .... Antares	1	8. 7.14.54	50.12	4.32.41 S.	+0.42
θ Ophiuchi............................	3	8.18.52.48	50.20	1.49. 1 S.	+0.48
α Ophiuchi ...... *Ras Alhague*..........	2	8.19.55.23	50.21	35.52.26 N.	−0.48
σ Sagittarii	3	9. 9.52. 9	50.21	3.25.18 S.	+0.46
α Lyræ .... *Vega*.................	1	9.12.47.19	49.89	61.44.26 N.	−0.45
π Sagittarii	3.4	9.13.44.18	50.19	1.27.46 N.	−0.45
γ Aquilæ	3	9.28.25.48	50.03	31.15.43 N.	−0.39
α Aquilæ .... Atair	1.2	9.29.14.10	50.79	29.18.45 N.	+0.08
β Aquilæ	3	9.29.55.13	50.05	26.42.32 N.	−0.38
α 2 Capricorni	3	10. 1.20.30	50.15	6.56.59 N.	−0.37
β Capricorni	3	10. 1.31.52	50.17	4.36.32 N.	−0.37
γ Capricorni	4.3	10.19.16. 3	50.21	2.32.15 S.	+0.26
δ Capricorni	3	10.21. 1. 7	50.21	2.33.49 S.	+0.25
α Aquarii	3	11. 0.50.36	50.11	10.40.16 N.	−0.18
α Pisca. Aust..... Fomalhaut	1	11. 1.19.32	50.59	21. 6.40 S.	+0.21
α Cygni.......... *Deneb*	1.2	11. 2.51.16	49.42	59.54.57 N.	−0.16
α Pegasi......... Markab............	2	11.20.58.44	50.11	19.24.44 N.	+0.10

TABLE XXXVIII.
Reduct. of lat. and Hor. Par. for Ellipticity $\frac{1}{300}$

Lat.	Reduct. of Lat.	Red. ☽ Hor. Par. Horizontal Par. 53′	57′	61′
°	′ ″	″	″	″
0	0. 0.0	0.0	0.0	0.0
2	0.47.9	0.0	0.0	0.0
4	1.35.5	0.1	0.1	0.1
6	2.22.7	0.1	0.1	0.1
8	3. 9.2	0.2	0.2	0.2
10	3.54.8	0.3	0.3	0.4
12	4.39.3	0.5	0.5	0.5
14	5.22.4	0.6	0.7	0.7
16	6. 3.9	0.8	0.9	0.9
18	6.43.7	1.0	1.1	1.2
20	7.21.5	1.2	1.3	1.4
22	7.57.2	1.5	1.6	1.7
24	8.30.7	1.8	1.9	2.0
26	9. 1.6	2.0	2.2	2.3
28	9.29.9	2.3	2.5	2.7
30	9.55.4	2.7	2.9	3.1
32	10.18.1	3.0	3.2	3.4
34	10.37.8	3.3	3.6	3.8
36	10.54.3	3.7	3.9	4.2
38	11. 7.7	4.0	4.3	4.6
40	11.17.8	4.4	4.7	5.0
42	11.24.7	4.7	5.1	5.5
44	11.28.2	5.1	5.5	5.9
46	11.28.4	5.5	5.9	6.3
48	11.25.1	5.9	6.3	6.7
50	11.18.6	6.2	6.7	7.2
52	11. 8.8	6.6	7.1	7.6
54	10.55.6	6.9	7.5	8.0
56	10.39.3	7.3	7.8	8.4
58	10.19.9	7.6	8.2	8.8
60	9.57.4	7.9	8.5	9.1
62	9.32.0	8.3	8.9	9.5
64	9. 3.8	8.6	9.2	9.9
66	8.32.9	8.8	9.5	10.2
68	7.59.6	9.1	9.8	10.5
70	7.23.8	9.4	10.1	10.8
72	6.45.9	9.6	10.3	11.0
74	6. 6.0	9.8	10.5	11.3
76	5.24.3	10.0	10.7	11.5
78	4.41.0	10.1	10.9	11.7
80	3.56.3	10.3	11.1	11.8
82	3.10.4	10.4	11.2	12.0
84	2.23.7	10.5	11.3	12.1
86	1.36.2	10.5	11.3	12.1
88	0.48.2	10.6	11.4	12.2
90	0. 0.0	10.6	11.4	12.2

TABLE XXXIX.
Aberration of Planets in Longitude.

Elong.	Uran	Sat.	Jup.	Mars	Venus. Elong	Venus. Ab.	Mercury. Elong	Mercury. Aph.	Mercury. Mea.	Mercury. Peri.
D	—	—	—	—	D	—″	D	—	—	—
Con. 0	25″	27″	29″	36″	S.C. 0	45½	S.C. 0	46″	51½″	59½″
15	24	26	28	35	15	41	5	46	51	58
30	22	24	26	33	30	34	10	44	48	52
45	19	21	23	28	45	19	15	41	43	41
60	15	16	19	23	Gt.El.	14	20	37	34	
75	10	12	14	18	45	9	25	29		
90	5	6	9	12	30	0	Gt.El.	13	18	19
	+					+	25	7		
105	1	1	3	7	15	3	20	1	4	
		+	+		Inf.C.	3½		+	+	+
120	5	4	1	3			15	2	4	2
135	10	8	5	+			10	5	8	13
150	13	11	9	2			5	6	11	16
165	15	13	11	3			Inf.C.	6	11½	19½
Op.180	15	13	11	4						

The aberration of the Sun in longitude is always 20″. The *apparent* place is given in the Nautical Almanac, and by adding 20″ the Sun's true longitude will be obtained.

TABLE XL.
Equat. Equinoxes in Longitude.

D	Long. ☽'s Node − 0 + 6	− 1 + 7	− 2 + 8	
0	0″0	8″9	15″5	30
2	0.6	9.5	15.8	28
4	1.2	10.0	16.1	26
6	1.9	10.5	16.4	24
8	2.5	11.0	16.6	22
10	3.1	11.5	16.8	20
12	3.7	12.0	17.0	18
14	4.3	12.4	17.2	16
16	4.9	12.9	17.4	14
18	5.5	13.3	17.5	12
20	6.1	13.7	17.6	10
22	6.7	14.1	17.7	8
24	7.3	14.5	17.8	6
26	7.8	14.8	17.9	4
28	8.4	15.2	17.9	2
30	8.9	15.5	17.9	0
	− 5 + 11	− 4 + 10	− 3 + 9	D

TABLE XLI.
Aberration in Long. and Lat.
Arg. Long = ☉ long — ✱ long.
Arg lat. = Arg long. — 3 signs

D	− 0 + 6	− 1 + 7	− 2 + 8	
0	20″0	17″3	10″0	30
2	20.0	17.0	9.4	28
4	20.0	16.6	8.8	26
6	19.9	16.2	8.1	24
8	19.8	15.8	7.5	22
10	19.7	15.3	6.8	20
12	19.6	14.9	6.2	18
14	19.4	14.4	5.5	16
16	19.2	13.9	4.8	14
18	19.0	13.4	4.2	12
20	18.8	12.9	3.5	10
22	18.5	12.3	2.8	8
24	18.3	11.8	2.1	6
26	18.0	11.2	1.4	4
28	17.7	10.6	0.7	2
30	17.3	10.0	0.0	0
	+ 5 − 11	+ 4 − 10	+ 3 − 9	D

Table XL. contains the *equation of the equinoxes* in longitude to be applied with its sign to the *mean* longitudes of all the heavenly bodies. Thus on July 16, 1820, when the longitude of the moon's ascending node was 11s. 26° 0′ the equation of the equinoxes was + 1″. 2.

The correction in Table XLI. corresponding to the Argument of Longitude being found, and its logarithm added to the log. secant (less radius) of the star's latitude will be the log. of the star's *aberration in longitude*, to be applied with its sign to the mean longitude. The logarithm of the correction in Table 41 corresponding to the Argument of Latitude added to the log. sine, of the star's latitude will be the *aberration of the star in latitude*, to be applied with its sign to the mean lat.

Example. Required the Aberration of *a* Pegasi, July 16, 1820?

☉ long. 3s 23°46′
✱ long. 11. 20. 59

Arg. long. 4. 2. 47 Tab. 41 + 10″. 8 log. 1.03342 Arg. lat. 1s. 2°. 47′ Tab. 41 — 16″. 9 log. 1.[illegible]
✱ Latitude 19° 25′ Sec. 0.02543 Sine 9.[illegible]171
✱ Aberr. long. + 11″ .5 Log. 1.05885 ✱ Aber. Lat. — 5″. 6 Log. 0.7[illegible]

TABLE XLII.

Aberration in Right Ascension and Declination.

Part I. Arg. R. A.=✱R.A. — ⊙ Long. Arg. Dec.=Arg.R. A.+3 signs.

D	0. 6. − +	1. 7. − +	2. 8. − +	
0	19″.17	16″.60	9″.59	30
1	19 .17	16 .43	9 .30	29
2	19 .16	16 .26	9 .00	28
3	19 .15	16 .08	8 .70	27
4	19 .13	15 .90	8 .40	26
5	19 .10	15 .71	8 .10	25
6	19 .07	15 .51	7 .80	24
7	19 .03	15 .31	7 .49	23
8	18 .99	15 .11	7 .18	22
9	18 .94	14 .90	6 .87	21
10	18 .88	14 .69	6 .56	20
11	18 .82	14 .47	6 .24	19
12	18 .75	14 .25	5 .92	18
13	18 .68	14 .02	5 .61	17
14	18 .60	13 .79	5 .28	16
15	18 .52	13 .56	4 .96	15
16	18 .43	13 .32	4 .64	14
17	18 .34	13 .08	4 .31	13
18	18 .23	12 .83	3 .99	12
19	18 .13	12 .58	3 .66	11
20	18 .02	12 .32	3 .33	10
21	17 .90	12 .07	3 .00	9
22	17 .78	11 .80	2 .67	8
23	17 .65	11 .54	2 .34	7
24	17 .52	11 .27	2 .00	6
25	17 .38	11 .00	1 .67	5
26	17 .23	10 .72	1 .34	4
27	17 .08	10 .44	1 .00	3
28	16 .93	10 .16	0 .67	2
29	16 .77	9 .87	0 .33	1
30	16 .60	9 .59	0 .00	0
	− + 11. 5.	− + 10. 4.	− + 9. 3.	D

Part II. Ar.R.A.= ✱ R.A.+⊙Lon. Ar.Dec.=Arg. R.A+3signs.

D	0. 6. + −	1. 7. + −	2. 8. + −	
0	0″.83	0″.72	0″.41	30
1	0 .83	0 .71	0 .40	29
2	0 .83	0 .70	0 .39	28
3	0 .83	0 .69	0 .38	27
4	0 .82	0 .69	0 .36	26
5	0 .82	0 .68	0 .35	25
6	0 .82	0 .67	0 .34	24
7	0 .82	0 .66	0 .32	23
8	0 .82	0 .65	0 .31	22
9	0 .82	0 .64	0 .30	21
10	0 .81	0 .63	0 .28	20
11	0 .81	0 .62	0 .27	19
12	0 .81	0 .61	0 .26	18
13	0 .81	0 .60	0 .24	17
14	0 .80	0 .59	0 .23	16
15	0 .80	0 .58	0 .21	15
16	0 .79	0 .57	0 .20	14
17	0 .79	0 .56	0 .19	13
18	0 .79	0 .55	0 .17	12
19	0 .78	0 .54	0 .16	11
20	0 .78	0 .53	0 .14	10
21	0 .77	0 .52	0 .13	9
22	0 .77	0 .51	0 .12	8
23	0 .76	0 .50	0 .10	7
24	0 .76	0 .49	0 .09	6
25	0 .75	0 .47	0 .07	5
26	0 .74	0 .46	0 .06	4
27	0 .74	0 .45	0 .04	3
28	0 .73	0 .44	0 .03	2
29	0 .72	0 .43	0 .01	1
30	0 .72	0 .41	0 .00	0
	+ − 11. 5.	+ − 10. 4.	+ − 9. 3.	D

Part III. Ar2dDec=⊙lon+✱Dec } Ad6signs Ar3dDec=⊙lon−✱Dec } itDecl.S.

D	0. 6. − +	1. 7. − +	2. 8. − +	
0	3″.98	3″.45	1″.99	30
1	3 .98	3 .41	1 .93	29
2	3 .98	3 .38	1 .87	28
3	3 .98	3 .34	1 .81	27
4	3 .97	3 .30	1 .75	26
5	3 .97	3 .26	1 .68	25
6	3 .96	3 .22	1 .62	24
7	3 .95	3 .18	1 .56	23
8	3 .94	3 .14	1 .49	22
9	3 .93	3 .09	1 .43	21
10	3 .92	3 .05	1 .36	20
11	3 .91	3 .00	1 .30	19
12	3 .89	2 .96	1 .23	18
13	3 .88	2 .91	1 .16	17
14	3 .86	2 .86	1 .10	16
15	3 .85	2 .82	1 .03	15
16	3 .83	2 .77	0 .96	14
17	3 .81	2 .72	0 .90	13
18	3 .79	2 .66	0 .83	12
19	3 .76	2 .61	0 .76	11
20	3 .74	2 .56	0 .69	10
21	3 .72	2 .51	0 .62	9
22	3 .69	2 .45	0 .55	8
23	3 .66	2 .40	0 .49	7
24	3 .64	2 .34	0 .42	6
25	3 .61	2 .28	0 .35	5
26	3 .58	2 .23	0 .28	4
27	3 .55	2 .17	0 .21	3
28	3 .52	2 .11	0 .14	2
29	3 .48	2 .05	0 .07	1
30	3 .45	1 .99	0 .00	0
	− + 11. 5.	− + 10. 4.	− + 9. 3.	D

To find the Aberration of a Star in Right Ascension.—Find the Equations in Part I. and II corresponding to the arguments of R. A. at the top of those tables, and connect them according to their signs, and to the log. of this sum or difference add the log. secant (less radius) of the star's declination, the sum will be the log. of the aberration in Right Ascension in seconds of a degree, which divided by 15 will be reduced to time, to be applied to the mean R. A.

To find the Aberration of a Star in Declination.—Increase the former arguments of R. A by 3 signs, and connect together the corresponding equations of Part I. and II. to the log. of which add the log. sine of the ✱'s declination, the sum will be the log. of arch 1st. With the arguments at the top of Part III. find in that Table arches 2d and 3d. These three arches connected with their signs will be the aberration in declination, to be applied to the *mean* declination.

Example. Required the Aberration in R. A. and Dec. of *a* Pegasi, July 16, 1820 ?

By table 8. ✱ R.A.=22h. 55′ 48″=11s.13°.57′. ✱Dec.14° 14′ N. and by N.A.⊙long 3s.23°46

✱R.A. 11s.13°.57′
⊙lon. 3. 23. 46

Diff. 7. 20. 11 Part I. +12.″27 | Diff.+3s= 10s.20°.11′ Pt I. — 14″.73
Sum 3. 7. 43 Part II.— 0. 11 | Sum+3 = 6. 7 43 PtII. — 0. 82

+12. 16 log. 1.08493 | — 15. 55 log. 1.1917
✱ Decl. 14° 14′ sec. 0.01354 | . . . Sine 9.3907

✱ Aber. R. A. +12″. 5 log. 1.09847 | Arch 1st — 3″.82 log. 0.5824

✱Ab.inR.A.in time 0″.83 ⊙long + ✱ Dec 4s. 8°. 0′ Arch 2d + 2. 45 } { If Decl. is S. add 6s. to
⊙long — ✱ Dec 3. 9. 32 Arch 3d + 0. 66 } { the Argum. Part. III

✱ Aberr. in Declination — 0. 71

Nutation in Right Ascension and Declination to be applied to the mean values.

Part I.
rg. R.A.=✱R.A.— Lon. ☽ node + 6 signs if Dec. is S.
rg. Dec. = Arg. R. A. + 3 signs.

D	0. 6.	1. 7.	2. 8.	
	— +	— +	— +	
0	8″.33	7″.21	4″.16	30
1	8 .33	7 .14	4 .04	29
2	8 .32	7 .06	3 .91	28
3	8 .32	6 .99	3 .78	27
4	8 .31	6 .91	3 .65	26
5	8 .30	6 .82	3 .52	25
6	8 .28	6 .74	3 .39	24
7	8 .27	6 .65	3 .25	23
8	8 .25	6 .56	3 .12	22
9	8 .23	6 .47	2 .99	21
10	8 .20	6 .38	2 .85	20
11	8 .18	6 .29	2 .71	19
12	8 .15	6 .19	2 .57	18
13	8 .12	6 .09	2 .44	17
14	8 .08	5 .99	2 .30	16
15	8 .05	5 .89	2 .16	15
16	8 .01	5 .79	2 .02	14
17	7 .97	5 .68	1 .87	13
18	7 .92	5 .57	1 .73	12
19	7 .88	5 .46	1 .59	11
20	7 .83	5 .35	1 .45	10
21	7 .78	5 .24	1 .30	9
22	7 .72	5 .13	1 .16	8
23	7 .67	5 .01	1 .02	7
24	7 .61	4 .90	0 .87	6
25	7 .55	4 .78	0 .73	5
26	7 .49	4 .66	0 .58	4
27	7 .42	4 .54	0 .44	3
28	7 .35	4 .41	0 .29	2
29	7 .29	4 .29	0 .15	1
30	7 .21	4 .16	0 .00	0
	— +	— +	— +	D
	11. 5.	10. 4.	9. 3.	

Part II.
Arg. R. A.=✱R.A.+lon. ☽ node + 6 signs if Dec. is S.
Arg. Dec. = Arg. R. A + 3 signs.

D	0. 6.	1. 7.	2. 8.	
	— +	— +	— +	
0	1″.22	1″.06	0″.61	30
1	1 .22	1 .05	0 .59	29
2	1 .22	1 .03	0 .57	28
3	1 .22	1 .02	0 .55	27
4	1 .22	1 .01	0 .53	26
5	1 .22	1 .00	0 .52	25
6	1 .21	0 .99	0 .50	24
7	1 .21	0 .97	0 .48	23
8	1 .21	0 .96	0 .46	22
9	1 .20	0 .95	0 .44	21
10	1 .20	0 .93	0 .42	20
11	1 .20	0 .92	0 .40	19
12	1 .19	0 .91	0 .38	18
13	1 .19	0 .89	0 .36	17
14	1 .18	0 .88	0 .34	16
15	1 .18	0 .86	0 .32	15
16	1 .17	0 .85	0 .30	14
17	1 .17	0 .83	0 .27	13
18	1 .16	0 .82	0 .25	12
19	1 .15	0 .80	0 .23	11
20	1 .15	0 .78	0 .21	10
21	1 .14	0 .77	0 .19	9
22	1 .13	0 .75	0 .17	8
23	1 .12	0 .73	0 .15	7
24	1 .11	0 .72	0 .13	6
25	1 .11	0 .70	0 .11	5
26	1 .10	0 .68	0 .09	4
27	1 .09	0 .66	0 .06	3
28	1 .08	0 .65	0 .04	2
29	1 .07	0 .63	0 .02	1
30	1 .06	0 .61	0 .00	0
	— +	— +	— +	D
	11. 5.	10. 4.	9. 3.	

Part III.
Equation Equinoxes in R.A.
Arg. = Long. ☽ node ☊

D	0. 6.	1. 7.	2. 8.	
	— +	— +	— +	
0	0″.0	8″.2	14″.2	30
1	0 .3	8 .4	14 .3	29
2	0 .6	8 .7	14 .5	28
3	0 .9	8 .9	14 .6	27
4	1 .1	9 .2	14 .7	26
5	1 .4	9 .4	14 .8	25
6	1 .7	9 .6	15 .0	24
7	2 .0	9 .9	15 .1	23
8	2 .3	10 .1	15 .2	22
9	2 .6	10 .3	15 .3	21
10	2 .8	10 .5	15 .4	20
11	3 .1	10 .7	15 .5	19
12	3 .4	11 .0	15 .6	18
13	3 .7	11 .2	15 .7	17
14	4 .0	11 .4	15 .7	16
15	4 .2	11 .6	15 .[illegible]	15
16	4 .5	11 .8	15 .9	14
17	4 .8	12 .0	16 .0	13
18	5 .1	12 .2	16 .0	12
19	5 .3	12 .4	16 .1	11
20	5 .6	12 .5	16 .1	10
21	5 .9	12 .7	16 .[illegible]	9
22	6 .1	12 .9	16 .[illegible]	8
23	6 .4	13 .1	16 .3	7
24	6 .7	13 .3	16 .3	6
25	6 .9	13 .4	16 .3	5
26	7 .2	13 .6	16 .3	4
27	7 .4	13 .7	16 .4	3
28	7 .7	13 .9	16 .4	2
29	7 .9	14 .0	16 .4	1
30	8 .2	14 .2	16 .4	0
	+ —	+ —	+ —	D
	11. 5.	10. 4.	9. 3	

To find the Nutation of a Star in Right Ascension.—Find in Parts I. II. the Equations orresponding to the arguments of R. A. at the top of the tables, connect them according the signs, and to the log. of the sum or difference add the log. tangent of the star's delination, the sum will be the log. of an arch, to which apply the equation of the equioxes, Part III. corresponding to the long. of the ☽'s node (page 3, N. A.) the sum or difrence will be the Nutation in Right Ascension in seconds of a degree, which divided by 5 will be reduced to seconds of time.

To find the Nutation of a Star in Declination.—Increase the arguments of R. A. Parts I . by 3 signs, and connect the corresponding equations of those tables, which will be the utation of declination. *Note.* In putting the R. A. of the star equal to 3 signs, the nutaon in declination will be the *equation of the obliquity of the ecliptic.*

Example. Required the Nutation of *a* Pegasi, in R. A. and Decl. July 16, 1820?

R.A. Tab. 8 11s.13°.57′
Node N. A. 11. 26. 0

Diff. 11. 17.57 Part I. —8″15
Sum 11. 9.57 Part II.—1. 15

—9. 30 log 0.96848
✱ Declination 14° 14′ tang. 9.40425

Arch — 2″.4 log 0.37273
rt III Eq. Arg. 11s. 26°.0′ + 1 1
Nutation in Right Ascension — 1. 3=—0″1 of t.

Diff.+3s=2s.17°57′ Part I.—1″74
Sum+3s=2. 9. 57 Part II.— 42

Nut. in Dec. —2 .16

6s.—☽ Node=6s. 4d. Part I +[illegible]
6s.+☽ Node=5s. 26d. Part II +[illegible]

Equat. Obliq. Eclipt. +[illegible]

If the Declination of the Star was south, the arguments Part I. II. of Right Ascension and eclination must be increased 6 signs.

TABLE XLIV.

To find the Augmentation of the Moon's Semidiameter, by the altitude of the Nonagesimal and the apparent distance of the Moon therefrom.

Part I.
Arg. = Alt. nona + ap. dist. ☾ from nona.
= Alt. nona. — ap. dist. ☾ from nona.

D	0. 6. + −	1. 7. + −	2. 8. + −	
0	0.″00	4.″09	7.″09	30
1	0. 14	4. 22	7. 16	29
2	0. 29	4. 34	7. 23	28
3	0. 43	4. 46	7. 29	27
4	0. 57	4. 58	7. 36	26
5	0. 71	4. 69	7. 42	25
6	0. 86	4. 81	7. 48	24
7	1. 00	4. 93	7. 53	23
8	1. 14	5. 04	7. 59	22
9	1. 28	5. 15	7. 64	21
10	1. 42	5. 26	7. 69	20
11	1. 56	5. 37	7. 74	19
12	1. 70	5. 48	7. 78	18
13	1. 84	5. 58	7. 83	17
14	1. 98	5. 69	7. 87	16
15	2. 12	5. 79	7. 91	15
16	2. 26	5. 89	7. 94	14
17	2. 39	5. 99	7. 97	13
18	2. 53	6. 08	8. 01	12
19	2. 66	6. 18	8. 03	11
20	2. 80	6. 27	8. 06	10
21	2. 93	6. 36	8. 08	9
22	3. 07	6. 45	8. 10	8
23	3. 20	6. 54	8. 12	7
24	3. 33	6. 62	8. 14	6
25	3. 46	6. 70	8. 15	5
26	3. 59	6. 79	8. 16	4
27	3. 72	6. 86	8. 17	3
28	3. 84	6. 94	8. 18	2
29	3. 97	7. 02	8. 18	1
30	4. 09	7. 09	8. 18	0
	− + 11. 5.	− + 10. 4.	− + 9. 3.	D.

Part II.

Arg. Sum of Equat. Part I.	Corr. +
1″.	0″ 00
2 .	0 .00
3 .1	0 .01
4 .4	0 .02
5 .4	0 .03
6 .2	0 .04
6 .9	0 .05
7 .6	0 .06
8 .2	0 .07
8 .8	0 .08
9 .3	0 .09
9 .8	0 .10
10 .3	0 .11
10 .7	0 .12
11 .2	0 .13
11 .6	0 .14
12 .0	0 .15
12 .4	0 .16
12 .8	0 .17
13 .1	0 .18
13 .5	0 .19
13 .9	0 .20
14 .2	0 .21
14 .5	0 .22
14 .9	0 .23
15 .2	0 .24
15 .5	0 .25
15 .8	0 .26
16 .1	0 .27
16 .4	0 .28
16 .7	0 .29

Part III.
Argument ☾'s Parallax in Lat.

Arg. ☽'s true Latit.	0′	10′	20′	30′	40′	50′	60′
South		−	−	−	−	−	−
6° 0′	0″.00	0″.30	0″.60	0″.92	1″.24	1″.57	1″.91
5. 0	0 .00	0 .25	0 .50	0 .77	1 .04	1 .32	1 .61
4. 0	0 .00	0 .20	0 .41	0 .62	0 .85	1 .08	1 .32
3. 30	0 .00	0 .17	0 .36	0 .55	0 .75	0 .96	1 .17
3. 0	0 .00	0 .15	0 .31	0 .48	0 .65	0 .83	1 .02
2. 40	0 .00	0 .13	0 .28	0 .43	0 .59	0 .75	0 .93
2. 20	0 .00	0 .12	0 .24	0 .38	0 .52	0 .67	0 .83
2. 0	0 .00	0 .10	0 .21	0 .33	0 .46	0 .59	0 .73
1. 40	0 .00	0 .09	0 .18	0 .28	0 .39	0 .51	0 .63
1. 20	0 .00	0 .07	0 .15	0 .23	0 .32	0 .43	0 .54
1. 0	0 .00	0 .05	0 .11	0 .18	0 .26	0 .35	0 .44
0. 40	0 .00	0 .04	0 .08	0 .13	0 .19	0 .26	0 .34
0. 20	0 .00	0 .02	0 .05	0 .09	0 .13	0 .18	0 .24
0. 0	0 .00	0 .00	0 .02	0 .04	0 .06	0 .10	0 .15
North.		+					
0. 10	0 .00	0 .00	+	0 .01	0 .03	0 .06	0 .10
				+			
0. 20	0 .00	0 .01	0 .02	0 .01	+	0 .12	0 .05
						+	
0. 30	0 .00	0 .02	0 .03	0 .04	0 .03	0 .02	+
0. 40	0 .00	0 .03	0 .05	0 .06	0 .06	0 .06	0 .05
1. 0	0 .00	0 .04	0 .08	0 .11	0 .13	0 .14	0 .15
1. 20	0 .00	0 .06	0 .11	0 .16	0 .19	0 .22	0 .24
1. 40	0 .00	0 .08	0 .15	0 .21	0 .26	0 .30	0 .34
2. 0	0 .00	0 .09	0 .18	0 .26	0 .33	0 .39	0 .44
2. 20	0 .00	0 .11	0 .21	0 .30	0 .39	0 .47	0 .54
2. 40	0 .00	0 .13	0 .24	0 .35	0 .46	0 .55	0 .63
3. 0	0 .00	0 .14	0 .28	0 .40	0 .52	0 .63	0 .73
3. 30	0 .00	0 .17	0 .33	0 .48	0 .62	0 .75	0 .88
4. 0	0 .00	0 .19	0 .37	0 .55	0 .72	0 .87	1 .03
5. 0	0 .00	0 .24	0 .47	0 .70	0 .91	1 .12	1 .32
6. 0	0 .00	0 .29	0 .57	0 .84	1 .11	1 .37	1 61
	0′	+ 10′	+ 20′	+ 30′	+ 40′	+ 50′	+ 60′

Part IV. Arg. ☾'s Horiz. Semi. Diam.

Arg. Sum of Pre. Eq.	14′ 40″	14′ 50″	15′ 0″	15′ 10″	15′ 20″	15′ 30″	15′ 40″	15′ 50″	16′ 0″	16′ 10″	16′ 20″	16′ 30″	16′ 40″	16′ 50″
″	− ″	− ″	− ″	− ″	− ″	− ″	− ″	− ″	″	+ ″	+ ″	+ ″	+ ″	+ ″
1	0.16	0.14	0.12	0.10	0.08	0.06	0.04	0.02	0.00	0.02	0.04	0.06	0.09	0.11
2	0.32	0.28	0.24	0.20	0.16	0.12	0.08	0.04	0.00	0.04	0.08	0.13	0.17	0.21
3	0.48	0.42	0.36	0.30	0.24	0.18	0.12	0.06	0.00	0.06	0.13	0 19	0.26	0.32
4	0.64	0.56	0.48	0.41	0.33	0.25	0.16	0.08	0.00	0.08	0.17	0.25	0.34	0.43
5	0.80	0.70	0.61	0.51	0.41	0.31	0.21	0.10	0.00	0.10	0.21	0.32	0.43	0.53
6	0.96	0.84	0.73	0.61	0.49	0.37	0.25	0.12	0.00	0.13	0.25	0.38	0.51	0.64
7	1.12	0.98	0.85	0.71	0.57	0.43	0.29	0.15	0.00	0.15	0.29	0.44	0.60	0.75
8	1.28	1.12	0.97	0.81	0.65	0.49	0.33	0.17	0.00	0.17	0.34	0.51	0.68	0.86
9	1.44	1.26	1.09	0.91	0.73	0.55	0.37	0.19	0.00	0.19	0.38	0.57	0.77	0.96
10	1.60	1.41	1.21	1.01	0.82	0.62	0.41	0.21	0.00	0.21	0.42	0.63	0.85	1.07
11	1.76	1.55	1.33	1.12	0.90	0.68	0.45	0.23	0.00	0.23	0.46	0.70	0.94	1.18
12	1.92	1.69	1.45	1.22	0.98	0.74	0.49	0.25	0.00	0.25	0.51	0.76	1.02	1.28
13	2.08	1.83	1.57	1.32	1.06	0.80	0.54	0.27	0.00	0.27	0.55	0.83	1.11	1.39
14	2.24	1.97	1.70	1.42	1.14	0.86	0.58	0.29	0.00	0.29	0.59	0.89	1.19	1.50
15	2.40	2.11	1.82	1.52	1.22	0.92	0.62	0.31	0.00	0.31	0.63	0.95	1.28	1.60
16	2.56	2.25	1.94	1.62	1.31	0.98	0.66	0.33	0.00	0.34	0.67	1.02	1.36	1 71

Find in P. I. the two equations corresponding to the arguments at the top and connect them according to their signs. With this sum or difference take out the corresponding correction P. II. In occultations the correction P. III. is to be found with the ☾'s Par. in lat. at the top and her *true* lat. at the side, but in solar Eclipses this p. is nothing. Connect these three parts and with the sum enter the side column of P. IV. and find the ☾'s *Horiz.* Semi. Dia. at the top, the corresponding cor. applied, with its sign to the sum of the three first parts will give the *Aug.* of the ☾'s S. D.

Thus in Ex. 1. Prob. 5. Appendix. The Alt. Nonag. is 2s. 7° 59′. Dis. Nonag. (D.+P) 20° 46′, ☾ S. D. by N. A. 16′ 27″. 7. Hence Arg. P. I. are 2s. 7° 59′ ± 20° 46′ that is 2s. 28° 45′ and 1s. 17° 13′ to which correspond + 8″ 18 + 6″. 01 = + 14″ 19. This gives in P. II. + 0″ 21. P. III. is 0″. The sum of the three parts is + 14″. 4. with which and the ☾ S. D. 16′ 27″. 7. P. IV. is nearly + 0″ 8. this connected with 14″. 4 gives the Aug. of ☾'s S. D. 15″ 2. as in Prob. VI. Appendix.

TABLE XLV.

Equation of Second Differences to be applied to the *mean* longitude or latitude with a sign *contrary* to that of the mean of the second differences.

Ap. time after noon or midnight.		Second Difference. 1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	12′
h m	h m	″	″	″	″	″	″	″	″	″	″	″	″
0. 0	12. 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.10	11.50	0.4	0.8	1.2	1.6	2.1	2.5	2.9	3.3	3.7	4.1	4.5	4.9
0.20	11.40	0.8	1.6	2.4	3.2	4.1	4.9	5.7	6.5	7.3	8.1	8.9	9.7
0.30	11.30	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4
0.40	11.20	1.6	3.1	4.7	6.3	7.9	9.4	11.0	12.6	14.2	15.7	17.3	18.9
0.50	11.10	1.9	3.9	5.8	7.8	9.7	11.6	13.6	15.5	17.4	19.4	21.3	23.3
1. 0	11. 0	2.3	4.6	6.9	9.2	11.5	13.7	16.0	18.3	20.6	22.9	25.2	27.5
1.10	10.50	2.6	5.3	7.9	10.5	13.2	15.8	18.4	21.1	23.7	26.3	29.0	31.6
1.20	10.40	3.0	5.9	8.9	11.9	14.8	17.8	20.7	23.7	26.7	29.6	32.6	35.6
1.30	10.30	3.3	6.6	9.8	13.1	16.4	19.7	23.0	26.2	29.5	32.8	36.1	39.4
1.40	10.20	3.6	7.2	10.8	14.4	17.9	21.5	25.1	28.7	32.3	35.9	39.5	43.1
1.50	10.10	3.9	7.8	11.6	15.5	19.4	23.3	27.2	31.1	34.9	38.8	42.7	46.6
2. 0	10. 0	4.2	8.3	12.5	16.7	20.8	25.0	29.2	33.3	37.5	41.7	45.8	50.0
2.10	9.50	4.4	8.9	13.3	17.8	22.2	26.6	31.1	35.5	39.9	44.4	48.8	53.3
2.20	9.40	4.7	9.4	14.1	18.8	23.5	28.2	32.9	37.6	42.3	47.0	51.7	56.4
2.30	9.30	4.9	9.9	14.8	19.8	24.7	29.7	34.6	39.6	44.5	49.5	54.4	59.4
2.40	9.20	5.2	10.4	15.6	20.7	25.9	31.1	36.3	41.5	46.7	51.9	57.0	62.2
2.50	9.10	5.4	10.8	16.2	21.6	27.1	32.5	37.9	43.3	48.7	54.1	59.5	64.9
3. 0	9. 0	5.6	11.2	16.9	22.5	28.1	33.7	39.4	45.0	50.6	56.2	61.9	67.5
3.10	8.50	5.8	11.7	17.5	23.3	29.1	35.0	40.8	46.6	52.4	58.3	64.1	69.9
3.20	8.40	6.0	12.0	18.1	24.1	30.1	36.1	42.1	48.1	54.2	60.2	66.2	72.2
3.30	8.30	6.2	12.4	18.6	24.8	31.0	37.2	43.4	49.6	55.8	62.0	68.2	74.4
3.40	8.20	6.4	12.7	19.1	25.5	31.8	38.2	44.6	50.9	57.3	63.7	70.0	76.4
3.50	8.10	6.5	13.0	19.6	26.1	32.6	39.1	45.7	52.2	58.7	65.2	71.7	78.3
4. 0	8. 0	6.7	13.3	20.0	26.7	33.3	40.0	46.7	53.3	60.0	66.7	73.3	80.0
4.20	7.40	6.9	13.8	20.8	27.7	34.6	41.5	48.4	55.4	62.3	69.2	76.1	83.1
4.40	7.20	7.1	14.3	21.4	28.5	35.6	42.8	49.9	57.0	64.2	71.3	78.4	85.6
5. 0	7. 0	7.3	14.6	21.9	29.2	36.5	43.7	51.0	58.3	65.6	72.9	80.2	87.5
5.20	6.40	7.4	14.8	22.2	29.6	37.0	44.4	51.9	59.3	66.7	74.1	81.5	88.9
5.40	6.20	7.5	15.0	22.4	29.9	37.4	44.9	52.3	59.8	67.3	74.8	82.2	89.7
6. 0	6. 0	7.5	15.0	22.5	30.0	37.5	45.0	52.5	60.0	67.5	75.0	82.5	90.0

Ap. time after noon or midnight.		Second Difference. 10″	20″	30″	40″	50″	1″	2″	3″	4″	5″	6″	7″	8″	9″
h m	h m	″	″	″	″	″	″	″	″	″	″	″	″	″	″
0. 0	12. 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.10	11.50	0.1	0.1	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
0.20	11.40	0.1	0.3	0.4	0.5	0.7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
0.30	11.30	0.2	0.4	0.6	0.8	1.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2
0.40	11.20	0.3	0.5	0.8	1.0	1.3	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
0.50	11.10	0.3	0.6	1.0	1.3	1.6	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3
1. 0	11. 0	0.4	0.8	1.1	1.5	1.9	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3
1.10	10.50	0.4	0.9	1.3	1.8	2.2	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4
1.20	10.40	0.5	1.0	1.5	2.0	2.5	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4
1.30	10.30	0.5	1.1	1.6	2.2	2.7	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5
1.40	10.20	0.6	1.2	1.8	2.4	3.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5
1.50	10.10	0.6	1.3	1.9	2.6	3.2	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6
2. 0	10. 0	0.7	1.4	2.1	2.8	3.5	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6
2.10	9.50	0.7	1.5	2.2	3.0	3.7	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7
2.20	9.40	0.8	1.6	2.3	3.1	3.9	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7
2.30	9.30	0.8	1.6	2.5	3.3	4.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.7
2.40	9.20	0.9	1.7	2.6	3.5	4.3	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8
2.50	9.10	0.9	1.8	2.7	3.6	4.5	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8
3. 0	9. 0	0.9	1.9	2.8	3.7	4.7	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7	0.8
3.10	8.50	1.0	1.9	2.9	3.9	4.9	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3.20	8.40	1.0	2.0	3.0	4.0	5.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3.30	8.30	1.0	2.1	3.1	4.1	5.2	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3.40	8.20	1.1	2.1	3.2	4.2	5.3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0
3.50	8.10	1.1	2.2	3.3	4.3	5.4	0.1	0.2	0.3	0.4	0.5	0.7	0.8	0.9	1.0
4. 0	8. 0	1.1	2.2	3.3	4.4	5.6	0.1	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.0
4.20	7.40	1.2	2.3	3.5	4.6	5.8	0.1	0.2	0.3	0.5	0.6	0.7	0.8	0.9	1.0
4.40	7.20	1.2	2.4	3.6	4.8	5.9	0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.1
5. 0	7. 0	1.2	2.4	3.6	4.9	6.1	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1
6. 0	6. 0	1.2	2.5	3.7	5.0	6.2	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0	1.1

TABLE XLVI. Latitudes and Longitudes.

[*This Table contains the* LATITUDES *and* LONGITUDES *of the most remarkable Harbo[urs,] Islands, Shoals, Capes, &c. in the* WORLD, *founded on the latest and most accurate As[tro]nomical observations, surveys and charts.*]

The Longitudes are reckoned from the meridian of Greenwich.

I. COAST OF THE UNITED STATES OF AMERICA.

		Lat. D.	Lat. M.	Long. D.	Long. M.
	ENTRANCE of St. Croix River	45	7N	67	8W
	Island of Campo-Bello (middle or West passage of Passamaquoddy Bay)	44	57	66	54
	Wolves' Islands	45	4	66	41
	E. end of Grand-Manan	44	47	66	43
	Grand-Manan N. head	44	53	66	45
	do. West end	44	40	66	55
	Titmanan Light	44	25	67	40
	Entrance of Machias River	44	44	67	20
	Gouldsboro' Harbour	44	34	67	52
	Mount Desert Rock	43	52	68	9
	Long-Island (south of Mount Desert or entrance of Blue-Hill Bay)	44	9	68	31
Maine.	Isle of Holt	44	00	68	40
	Castine	44	24	68	46
	Matinicus Island	43	50	68	55
	Wooden Bald Rock	43	45	68	54
	Island of Manheigin	43	44	69	15
	Penmaquid Point	43	48	69	27
	Bantum Ledges	43	42	69	33
	Kennebeck River entrance	43	43	69	47
	Seguine Island light	43	41	69	46
	Cape Small point	43	40	69	52
	Cashe's Ledge (shoalest part)	43	4	69	11
	Alden's Ledge (off Cape Elizabeth)	43	28	70	9
	Brunswick	43	52		
	PORTLAND light-hou.	43	39	70	17
	Cape Elizabeth	43	33	70	15
	Saco River entrance	43	28	70	26
	Wood Island L. House	43	27	70	23
	Agamenticus Hill	43	16	70	41
	Cape Porpoise	43	21	70	26
	Wells Harbour	43	19	70	33
	Bald Head	43	13	70	35
	Cape Neddock Nubble	43	10	70	36
	York River	43	7	70	38
N. Hamp.	York Ledge	43	6	70	34
	Boon Island light	43	6	70	31
	Boon Island Ledge	43	4	70	27
	PORTSMOUTH light-house	43	4	70	44
	Portsmouth	43	5	70	46
	Isles of Shoals light	42	56	70	38
	NEWBURYPORT lights on Plumb Island	42	48	70	51
Mass.	Ipswich entrance	42	43	70	49
	Squam light	42	42	70	41
	Sandy Cove (or Bay)	42	41	70	38
	CAPE ANN light houses on Thatcher's Island	42	40	70	34
	East point of Cape Ann Harbour	42	37	70	39

		Lat. D.	Lat. M.	Lon[g.] D.	[M.]
	Light houses on Baker's Island	42	34N	70	4
	Beverly	42	34	70	5
	SALEM	42	33	70	5
	Marblehead	42	32	70	5
	Nahant Point (N. E. Point of Boston harbour)	42	28	70	5
	Boston light-house	42	20	70	5
	BOSTON	42	23	71	
	CAMBRIDGE (Mass)	42	23	71	
	Scituate light	42	11	70	4
Massachusetts.	Plymouth lights	41	59	70	3
	Race Point light	42	6	70	1
	CAPE COD light	42	5	70	
	Chatham light	41	43	69	5
	Sandy Point or Malabar	41	34	69	5
	Shoal of George,				
	Great Shoal S. E. P.	41	34	67	4
	do. do. W. P.	41	42	67	5
(*True lat. by Blunt.*)	do. do. N. E. P.	41	48	67	4
	do. North Shoal	41	53	67	4
	do. Third Shoal	41	51	67	2
	do. East Shoal	41	47	67	1
	NANTUCKET light-house	41	23	70	0
	Sancoty head on Nantucket Island	41	16	69	5
	Tom Nevers head	41	14	69	5
	Nantucket South Shoal (true lat. by Blunt)	41	4	69	5
	Cape Poge, (Vineyard)	41	25	70	2
	Squibnocket-head (southwesterly part of Martha's Vineyard)	41	17	70	4
	Gay Head light-house, (Vineyard)	41	21	70	5
R. Island.	Noman's Land Island	41	15	70	4
	New-Bedford light hou.	41	35	70	5
	Buzzard's Bay entrance	41	28	70	5
	NEWPORT	41	29	71	1
	Rhode Island light-hou.	41	28	71	2
	Point Judith L. house	41	24	71	2
	Watch Hill P. light	41	20	71	5
Connect.	Little Gull light	41	14	72	1
	Block Island	41	10	71	3
	New-London (or entrance of Thames river) light-house	41	21	72	1
	Falkland Island L.house	41	15	72	4
	NEW-HAVEN entr'ce.	41	17	72	5
	Montock Point (E. end of Long-Island) light house	41	4	71	5
New-York.	East Hampton in do.	41	00	72	1
	NEW-YORK City	40	42	74	0
	New-York light-house on Sandy Point	40	28	74	
	Perth Amboy	40	30	7[illegible]	
N. Jer.	Little Egg Harbour	39	30		
	Great Egg Harbour	39	18		
	Cape May	38	57		
	PHILADELPHIA	39	57		
	Light-house on Cape Henlopen	38			

		Lat.		Long.	
		D.	M.	D.	M.
Virginia.	Cape Charles . . .	37	7N	76	15W
	Cape Henry light . . .	36	56	76	18
Virginia and Maryland.	Norfolk (Vir.) . . .	36	53	76	34
	Petersburgh (Vir.) . .	37	12	77	44
	York Town (Vir.) .	37	12	76	38
	RICHMOND (Vir.) .	37	30	77	44
	Annapolis (Mar.) . .	39	00	76	37
	ALEXANDRIA (Vir.)	38	49	77	4
	WASHINGTON City	38	53	77	2
	Chincoteague Shoals (on Maryland shore)	37	58	75	15
	BALTIMORE . . .	39	23	76	39
	Roanoke Inlet . . .	35	50	75	35
	CAPE HATTERAS .	35	14	75	30
	Extreme shoal off do. .	35	3	75	23
	Deep soundings off do.	34	56	75	9
	Ocracock Inlet . . .	35	1	75	59
	Cedar Inlet	34	47	76	22
	CAPE LOOKOUT .	34	34	76	37
	Extreme shoal off do. .	34	21	76	32
	Deep soundings off do.	34	7	76	12
	Old Topsail Inlet . .	34	39	76	46
	Beaufort (N. C.) . .	34	42	76	46
North-Carolina.	Cheesman's Inlet . .	34	41	76	51
	Bouge Inlet	34	38	77	14
	Swansborough . . .	34	41	77	17
	Bear Inlet	34	36	77	21
	New River Inlet . .	34	34	77	30
	Stump Inlet	34	31	77	37
	New Topsail Inlet . .	34	27	77	44
	Sandy Inlet	34	19	77	55
	Deep Inlet	34	14	78	00
	WILMINGTON . .	34	17	78	10
	Brunswick	34	3	78	10
	Smithville	33	54	78	13
	New Inlet	33	57	78	6
	CAPE FEAR . . .	33	48	78	9
	Extreme shoal off do. .	33	36	77	47
	Deep soundings off do.	33	11	77	26
South-Carolina.	Lockwood's Folly Inlet	33	53	78	25
	Shallot	33	51	78	39
	Little River Inlet . .	33	50	78	49
	GEORGETOWN . .	33	25	79	00
	Ditto light . . .	33	13	78	55
	Shoals off do. . . .	33	8	78	42
	Cape Roman . . .	33	2	79	6
	CHARLESTON . .	32	46	79	48
	Charleston light-house .	32	40	79	40
	North Eddisto Inlet .	32	30	79	59
	South Eddisto Inlet .	32	28	80	7
	BEAUFORT (S. C.) .	32	28	80	33
	Port Royal entrance .	32	8	80	27
Georgia.	Tybee light . . .	32	00	80	49
	SAVANNAH . . .	32	2	81	3
	St. Catherine's Sound .	31	37	81	13
	St. Simon's Sound . .	31	1	81	36
	Brunswick (Geo.) . .	31	10		
E. C. of Florida.	Amelia Sound (entrance of St. Mary's river) .	30	44	81	43
	Cumberland Isl. (S. P.)	30	43	81	35
	Amelia Island (S. P.) .	30	28	81	36
	River Nassau entrance	30	28	81	35
	River St. John entrance	30	21	81	35
	St. Augustine . . .	29	51	81	28
	Island Anastasia, N. P.	29	51	81	23
	— S. P.	29	37	81	17

		Lat.		Long.	
		D.	M.	D.	M.
East Coast of Florida.	Muskito or N. Smyrna entrance . . .	28	52N	80	56W
	Cape Canaveral . .	28	18	80	33
	Outer breakers off do.	28	20	80	13
	Las Tortolas or Hummocks	27	35	80	30
	Hillsborough Isl. N. P.	27	31	80	19
	— S. P. . . .	27	16	80	13
	Mount Pelado or Bald Head	27	1	80	11
	Grenville's Inlet . .	26	47	80	2
	Cooper's Hill . .	26	42	80	3
	Sand Hills . . .	26	32	80	3
	New Inlet	26	17	80	6
	Middle River entrance	26	7	80	7
	CAPE FLORIDA . .	25	42	80	9
	Aliol, N. P. . . .	25	20	80	20
	Cuyo Largo or Long Key, N. E. P. .	24	57	80	35
	— S. E. P. . . .	24	52	80	34
	Sombrero or Hat Key .	24	32	81	23
	Looe Key . . .	24	28	81	37
South Coast of Florida.	Samboes . . .	24	25	81	47
	Sand Key or C. Arena	24	21	81	59
	S. W. end of shoals off C. Florida . . .	24	20	82	31
	Tortugas Islands and Banks. N. W. part .	24	34	83	2
	— N. E. do. . . .	24	37	82	45
	— S. E. do. . . .	24	33	82	45
	— S. W. do. . . .	24	25	83	00
	Key Marquis . . .	24	30	82	13
	Boca Grande or Great Mouth . . .	24	32	82	11
	Key Samba . . .	24	35	81	53
	Island of Pines . .	24	42	81	41
	Keys of Bay Honda .	24	44	81	29
	Key Vacas . .	24	41	81	17
	Key Agi	24	48	81	16
	Cape Sable or Tancha .	24	50	81	19
West Coast of Florida.	Cape Romano or P. Larga . . .	26	00	81	51
	Boca Grande ent. B. Carlos . . .	26	41	82	10
	Boca Serraxota . . .	27	16	82	37
	Spirito Santo Bay ent.	27	38	82	47
	Keys Anclote . .	28	11	83	7
	Keys of St. Martin . .	28	42	83	1
	Fresh water Keys .	29	8	83	5
	Cayos de Cedres . .	29	23	83	5
	St. Marcos de Apalache	30	9	84	19
	South Cape . . .	29	48	84	29
	St. George's Key, S. P.	29	30	85	18
	Cape St. Blas . .	29	36	85	35
	Bay St. Andres (E. point of Island Rosa) . .	30	21	86	43
	Bay St. Rosa (W. point of do.) . . .	30	19	87	31
	PENSACOLA . . .	30	24	87	27
	River Perdido . .	30	18	87	46
	Mobile Point . .	30	13	88	21
	MOBILE . . .	30	40	88	21
	Massacre Island .	30	12	88	37
	I. del Cuerpo . .	30	12	88	49
	Candelarius, N. P. .	29	59	88	57
	— S. P.	29	28	89	12

		Lat. D.	Lat. M.	Long. D.	Long. M.
Louisiana.	Key Breton	29	28N	89	18W
	Entrance of MISSISSIPPI, N. E.	29	12	89	9
	— La Balisa	29	8	89	6
	— S. E.	28	59	89	13
	— S. W.	28	56	89	29
	NEW-ORLEANS	29	57	90	9
	Baton Rouge	30	36	91	13
	Long-Island	29	15	90	14
	I. Tonbalie, S. P.	28	52	90	39
	I. del Vino W. end	28	56	91	24
	Bancos de Hostiones,				
	— S. P.	28	50	91	44
	— W. P.	29	26	93	4
	Iron Point or Point Fierro	29	14	92	7
	Deer Point	29	26	92	29
	Point del Pajaro	29	24	92	48
	River Lobos, ent.	29	32	93	4
	Salt water Bay	29	26	93	28
	Constant Bay	29	27	93	39
	River Mermentao	29	38	94	11
	Point ent. river Sabine	29	40	94	57

II. *Islands in the West Indies.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
Windward Islands.	TRINIDAD,				
	— Spanish Town	10	39N	61	30W
	— Icaque Point	10	4	61	55
	— Point Galiote	10	9	60	55
	— Point Galera	10	51	60	51
	Tobago, N. E. Point	11	29	60	17
	—S. W. point	11	5	60	48
	Grenada, N. E. point	12	19	61	40
	— S. W. point	11	58	61	52
	Grenada Bank. Middle	11	55	62	18
	Barbadoes, S. P.	13	1	59	36
	— E. do.	13	8	59	24
	— Bridgetown	13	5	59	41
	— N. W. point	13	18	59	44
	St. Vincents, N. point	13	12	61	21
	— S. do.	13	4	61	20
	St. Lucia, S. point	13	30	61	00
	— N. do.	13	56	60	56
	Martinico, S. E. point	14	24	60	56
	— Diamond Rock	14	24	61	6
	— Port Royal	14	36	61	9
	— Macouba Point	14	56	61	28
	Dominica, S. point	15	14	61	28
	— N. do.	15	39	61	30
	The Saints Island	15	52	61	37
	Mariagalante, N. P.	16	4	61	14
	— S. do.	15	53	61	15
	Guadaloupe, S. W. P.	15	58	61	48
	— N. W. do.	16	20	61	56
	— N. E. do.	16	30	61	32
	— S. E. do.	16	11	61	15
	Deseada	16	21	61	8
	Antigua, E. P.	17	5	61	44
	— W. point.	17	5	62	00
	Monserrat, S. P.	16	42	62	17
	— N. P.	16	50	62	17
	Redondo Island	16	56	62	22
	Nevis	17	9	62	33
	St. Christ'rs or St. Kitts				
	— S. E. point	17	12	62	38
	St. Christ'rs or St. Kitts				
	— N. W. point	17	24N	62	51W
	St. Eustatia Town	17	29	63	2
	Saba	17	40	63	16
	Aves or Bird's I. about	15	40	63	40
	Barbuda, N. P.	17	44	61	50
	St. Bartholomew, E. P.	17	54	62	40
	St. Martin's, E. P.	18	4	63	1
	Anguila, S. W. point	18	12	63	8
	— N. E. do.	18	18	62	52
	Prickly Pear	18	20	63	15
	Isle of Dogs, western	18	19	63	20
	Sombrero	18	38	63	30
Virgin Islands.	St.Croix orSt.Cruz E.P.	17	45	64	34
	— W. P.	17	42	64	54
	Anegado, S. P. of shoal	18	36	64	9
	— W. P.	18	46	64	23
	Virgin Gorda, E. P.	18	30	64	18
	Tortola, E. P.	18	28	64	31
	— W. P.	18	25	64	42
	St. John's	18	22	64	42
	St. Thomas	18	22	64	55
	Bird Key	18	15	64	50
	Serpent I. E. part	18	19	65	17
	— Crab I. E. part	18	10	65	15
Porto Rico.	Cape St. John or N. E.	18	24	65	35
	PORTO RICO	18	29	66	5
	Point Bruquen or N.W.	18	31	67	7
	Point St. Francisco	18	22	67	13
	Cape Roxo or S. W. P.	17	58	67	9
	Los Morillos	18	00	67	16
	Point Coama	17	55	66	27
	C.MalaPasqua or SE.P.	17	59	65	47
	Shoal	19	20	65	50
	Muertos Island	17	52	66	30
	La Moon I.	18	6	67	50
	Monito I.	18	9	67	53
	Zacheo or Dessecheo I.	18	24	67	26
St. Domingo, or Hispaniola.	Cape Engano	18	35	68	20
	Saona I. E. part	18	13	68	31
	St. Catherine's I.	18	18	68	58
	St. Domingo	18	28	69	51
	La Catalina	18	8	70	11
	Cape Beata	17	42	71	20
	Altavela rock off do.	17	28	71	21
	Cape Jacquemel	18	13	72	35
	Island Baca	18	4	73	38
	Point Gravois	18	00	73	55
	Cape Tiberon	18	20	74	29
	Navaza Island	18	24	75	3
	Cape Donna Maria	18	38	74	27
	Jeremy	18	38	74	7
	Caymito	18	39	73	43
	Petit Guave	18	25	72	54
	Leogane	18	29	72	38
	PORT-AU-PRINCE	18	33	72	21
	I. Gonave, S. E. P.	18	42	72	47
	— N. W. P.	18	56	73	18
	St. Mark	19	4	72	45
	St. Nichola Mole	19	49	73	25
	Tortudas W. P.	20	6	72	54
	— E. P.	20	2	72	35
	CAPE FRANCOIS	19	45	72	13

	Lat.		Long.	
	D.	M.	D.	M.
Port Dauphin	19	42N	71	55W
Shoal off M. Christe	20	2	71	40
Monte Christe	19	54	71	43
Point Isabella	19	58	71	10
Old Cape Francois	19	40	69	55
Cape Samana	19	16	69	7
Cape Raphael	19	3	68	53
Jamaica.				
Morant, E. P.	17	58	76	9
KINGSTON	18	1	76	51
Port Royal	17	59	76	55
Portland Point	17	42	77	14
Pedro Bluffs	17	50	77	55
Black River	18	1	78	1
Savannah la-Mar	18	13	78	23
Cape Negril, S. point	18	14	78	37
— N. do.	18	24	78	35
Montego Bay	18	31	78	9
Martha Brae	18	31	77	49
St. Ann's	18	31	77	22
Galina Point	18	29	76	59
Arnatta Bay	18	21	76	51
N. E. Point	18	13	76	20
Morant Keys or Las Ranas	17	25	76	00
Pedro Shoals				
— Portland R. N. E. P.	17	00	77	13
— Rattlesnake, N. W. P.	17	5	79	13
— South part	16	43	78	26
Formigas Shoal, N.E.P.	18	34	75	42
— S. W. P.	18	28	75	51
Little Cayman, S. W. P.	19	36	80	5
Caymanbrack, E. P.	19	43	79	52
Grand Cayman, S.W.P.	19	18	81	5
— E. P.	19	18	80	37
Swan Islands	17	21	84	4
New Shoal	15	56	79	8
Navaza	18	24	75	3
South side of Cuba.				
Cape Mayze	20	14	74	4
C. Bueno or Guanos	20	6	74	12
Point ent. Cumberland Har.	19	54	75	11
St. JAGO DE CUBA, entrance	19	57	76	5
Tarquin's Peak	19	54	76	50
Cape Cruz	19	47	77	42
Boca del este	20	19	79	8
Key Breton	21	6	79	55
Trinidad river	21	44	80	5
Bay Xagua	21	53	80	48
Stone Keys	21	47	81	45
Los Jardines	21	37	81	31
S. E. point of the Bank	21	24	81	18
El Jardinillo	21	24	81	50
Keys Jardines	21	24	82	4
I. Pines. S. W. P.	21	22	82	55
Indian Keys	21	29	82	56
Keys St. Philip	21	48	83	6
Point Piedras	21	48	83	42
Cape Corientes	21	43	84	23
Cape St. Antonio	21	54	84	57
Sancho Pedro Shoal	22	4	85	28
Shoal discovered in 1797	22	6	85	2

	Lat.		Long.	
	D.	M.	D.	M.
North side of Cuba.				
Los Colorados, S. W.P.	22	19N	84	44W
— N. E. P.	22	58	83	5
Point Juan and Jaunito	22	22	84	21
Hill Guajibon	22	48	83	21
Bay Honda	22	54	83	5
Port Cabanas	22	58	82	52
MARIEL	23	1	82	45
River Banco	23	4	82	35
HAVANNAH (the Moro)	23	9	82	19
Point Escondido	23	8	81	47
Point Guanos	23	9	81	40
Pan of Matanzas	23	2	81	42
MATANZAS	23	2	81	36
Point Yeacos	23	8	81	9
Stone Key off do.	23	12	81	9
Key Cruz del Padre	23	14	80	55
Las Cabezas	23	16	80	43
Nicholas shoal	23	10	80	13
Key Carenero	22	51	79	49
Key Francis	22	40	79	17
Key William (northernmost)	22	36	78	34
St. Juan	22	14	78	58
Key Coco S. side Bahama channel	22	29	78	17
Key Point Paredon do.	22	30	79	5
The Barrel	22	25	77	56
Cayo Confites	22	11	77	40
Cayo or Key Verde	22	5	77	37
Guajava	21	54	77	25
Point Maternillos	21	40	76	59
Point de Mangle	21	13	76	14
Point de Mulas	21	7	75	34
Tanamo	20	43	75	13
Key Moa	20	44	74	49
Point Guarico	20	40	74	41
Baracoa	20	22	74	25
Shoal	19	56	69	5
Nativity bank or E. reef	20	8	68	41
Superb Shoal	20	58	68	59
Silver Key, S. E. end	20	15	69	29
— N. E. do.	20	32	69	27
— W. do.	20	29	69	59
Square Handkerchief, N. E. P.	21	20	70	23
— S. E. P.	20	56	70	28
— S. W. P.	20	53	70	56
Turk's-Island, Grand T.	21	30	71	3
— Salt Key	21	20	70	58
— Sand Key	21	12	71	10
— Endymion's Rocks	21	7	71	15
Caycos I.				
Great Caycos, south Part	21	31	71	27
— N. E. P. or shoal St. Philip	21	45	71	22
— N. W. part	21	54	71	47
North Caycos, middle	21	56	71	57
Booby Rocks off do.	21	58	71	57
Providence Caycos, N. W. P.	21	52	72	21
Little Caycos, S. W. P.	21	36	72	27
Key Francis	21	31	72	7
Sand Key	21	18	72	3
South Keys shoal	21	1	71	43

		Lat.		Long.	
		D.	M.	D.	M.
	Great Inagua or Heneaga, N. E. P. . .	21	19N	73	1W
	— S. E. P. . .	21	00	73	6
	— S. W. P. . .	20	54	73	41
	— N. W. P. . .	21	8	73	41
	Little Heneaga, E. P. .	21	28	72	55
	— W. P. . . .	21	28	73	7
	Hogsties or Corrolaes .	21	39	74	00
	Bank	21	57	72	55
	Mayaguana E. Reef .	22	17	72	39
	— N. do. . . .	22	30	73	6
	— S. W. point . .	22	20	73	11
	French Keys or I. Planas . . .	22	40	73	34
	Miraporvos Keys .	22	7	74	32
Passage Islands.	Castle Island or South Key . . .	22	8	74	20
	Fortune Island, W. P.	22	30	74	20
	North Key, Bird I. .	22	50	74	22
	Crooked Island, W. P.	22	48	74	18
	— E. P. . . .	22	38	73	50
	Atwood's Keys, or I. Samana, E. P. .	23	5	73	35
	— W. P. . . .	23	3	73	49
	Rum Key . . .	23	34	74	57
	Watland's I. N. E. P. .	24	6	74	26
	— S. E. P. . .	23	57	74	37
	Conception, or Little I.	23	52	75	16
	St. Salvador, or Guanabari, S. P. . .	23	57	75	32
	— N. P. . . .	24	33	75	49
	Little St. Salvador, N.P.	24	32	76	12
	Eleuthera or Hetera I.				
	— Powel's Point, S. P.	24	38	76	23
	— Point Palmeto .	25	12	76	26
	— James Point . .	25	24	76	36
	Harbour Island . .	25	29	76	50
	Egg Island, W. P. .	25	28	77	6
	New Providence . .				
	— NASSAU . .	25	5	77	22
	— E. P. . . .	24	59	77	9
	— W. P. . . .	24	59	77	35
	Andros Islands, S. P. .	24	4	77	45
	— N. P. . . .	25	24	78	3
Great Bahama Bank.	Berry Islands, Eastern	25	22	77	41
	— Northern . .	25	49	78	1
	— Great Harbour .	25	49	78	5
	Little Isaac, Eastern .	25	57	78	46
	Great Isaac . .	26	1	79	2
	Bemini Island, northern fresh water key .	25	43	79	8
	Cat Key . . .	25	23	79	10
	Riding Rocks . .	25	17	79	4
	Orange Keys, North .	24	58	79	6
	— South . . .	24	53	79	6
	Key Guinchos . .	22	44	78	1
	Key Lobos . . .	22	25	77	33
	Las Mucaras . .	22	10	77	12
	South edge of the Bank	22	5	76	22
	Key St. Domingo .	21	45	75	45
	St. Vincent's Shoal .	21	56	75	19
	Key Verde Island .	22	1	75	5
	Key Sal . . .	22	12	75	41
	Yuma or Long I. S. P.	22	49	74	46
	— N. P. . . .	23	30	75	19
	Exuma, N. W. P. .	23	36	75	51

		Lat.		Long.	
		D.	M.	D.	M.
	Leeward Stocking I. .	23	50N	76	10W
	THE HOLE IN THE WALL . . .	25	51	77	13
	Rocky point of Abaco .	26	14	77	5
	Elbow Key . .	26	31	77	00
	Man of War Key .	26	36	77	5
Little Bahama Bank.	Great Guano Key .	26	43	77	11
	Los Galapagos, N. P. .	27	22	78	21
	Lit. Bahama Bank, N.P.	27	50	79	11
	Memory Rock . .	26	58	79	4
	Sand Key . . .	26	54	79	1
	Wood Key, or C. Leno	26	46	79	00
	Great Bahama I. W. P.	26	38	78	55
	— S. P. . . .	26	21	78	35
	— E. P. . . .	26	19	78	9
	Dog Keys, N. P. . .	24	1	79	45
	Water Key . .	23	58	79	57
Salt Key Bank.	Double-headed Shot Key, Western . .	23	52	80	14
	Salt Key . . .	23	39	80	8
	Anguila, E. P. . .	23	27	79	14
	Bermuda . . .				
	— GEORGETOWN, .	32	22	64	33
Bermuda.	— Wreck Hill, westernmost-land . .	32	15	64	50
	Best Latitude to run for Bermuda . .	32	8		

III. *East Coast of America, from the Gulf of Mexico to Cape Horn.*

		Lat.		Long.	
		D.	M.	D.	M.
	Point Gulebrao, E. part I. St. Louis . .	29	10N	96	5W
	Point St. Francisco, entrance of Bay St. Bernard . . .	28	58	96	55
	Horse Inlet . .	28	8	97	35
	Point of the Coast .	26	46	97	35
	Bar de St. Jago . .	26	5	97	31
	River Brabo, ent. .	25	55	97	26
	River St. Fernando, ent.	25	22	97	32
	Inlets to Laguna Madre	25	2	97	41
	Bar de la Marine, entrance river St. Ander	23	45	97	58
East Coast of Mexico.	Bar del Tordo . .	22	52	97	57
	Mount Commandante .	22	48	97	58
	Bar de la Trinidad .	22	39	97	57
	Bar Ciega . . .	22	34	97	58
	River Tampico . .	22	16	98	2
	Point de Xeres . .	21	55	97	45
	Cape Rojo . . .	21	45	97	35
	Tamiagua City . .	21	16	97	45
	River Tuspan, ent. .	21	1	97	30
	Point Piedras . .	20	50	97	21
	River Cazones . .	20	44	97	15
	Tenestequepe . .	20	40	97	12
	Boca de Lima . .	20	37	97	7
	River Tocoluta, ent. .	20	30	97	1
	Mount Gordo . .	20	22	96	57
	River Nauta, ent. .	20	16	96	50
	River Palina, ent. .	20	10	96	45
	Point Piedras . .	20	00	96	35
	River de Santa Nos. .	19	55	96	30

	Lat. D.	Lat. M.	Long. D.	Long. M.
Point Delgada	19	52N	96	26W
Point N. Andrea	19	43	96	21
Point de Bernet	19	40	96	21
River St. John Angel	19	32	96	20
Xalapa	19	32	96	50
Peak de Orizaba	19	2	97	9
Point de Sampola	19	30	96	16
River St. Carlos	19	26	96	15
River Antigua	19	20	96	14
Point Gorda	19	15	96	4
VERA CRUZ	19	11	96	4
St. John de Ulloa	19	15	95	58
Xamapa	19	4	96	6
River Medellin, ent.	19	6	95	59
Point Auton Lisardo	19	4	95	45
Bar de Alvarado	18	46	95	38
Tlacotalpan	18	35	95	29
Vigia	18	38	95	18
Point Roca-Partida	18	40	94	59
Point Morillos	18	41	94	51
Tuxtla	18	18	95	5
Point Zapolitan	18	34	94	41
Point Xicacal	18	27	94	37
Point St. John	18	19	94	29
Barrilla	18	7	94	27
Bar Guazacoalios	18	8	94	12
River Tonelado	18	8	93	55
River St. Ann	18	8	93	41
River Cupilco	18	13	93	8
Dos Bocas	18	13	92	45
River Chittepeque	18	14	92	39
River Tabasco	18	22	92	7
River St. Peter & Paul	18	27	91	54
Point Jicalango	18	44	91	29
Island Carmen	18	46	91	14
Point Escondido	18	50	90	51
River Chen	19	20	90	36
Point Morros	19	40	90	39
CAMPECHE	19	50	90	30
Point Desconocida	20	55	90	29
Point Gorda	21	6	90	19
Point Piedras	21	9	90	13
Igil	21	20	89	19
St. Clara	21	22	88	45
Bocas de Silan	21	26	88	23
El Cuyo	21	30	87	43
Island Jolvas, N. P.	21	30	87	11
Island Contoy, N. P.	21	36	86	52
Las Arcas Islands	20	16	91	51
Bank Obispo	20	32	92	5
Triangles Islands	20	59	92	7
New Shoal	20	33	91	50
Bajo Neuva I.	21	50	91	48
Island Arenas	22	7	91	26
I. Bermeja, or N. W. Shoal	22	36	91	21
Bajo Sisal	21	27	90	2
Alacran	22	29	89	26
N. part of Bank off this coast	23	43	88	43
N. E. do.	23	27	86	37
I. de Mugeres, or Women's I.	21	18	86	42
I. Cankun, S. P.	20	42	86	58
New River	20	26	87	15
River Bacales	20	5	87	34

Region		Lat. D.	Lat. M.	Long. D.	Long. M.
	Bay Ascension, ent.	19	26N	88	3W
	Island Cosumel, N. P.	20	11	86	34
	— S. E. P.	19	52	86	32
	Rio Hondo, ent.	19	4	88	17
	I. Ubero, N. P.	19	20	88	3
	— S. P.	18	22	87	53
	I. St. Cruz	18	20	87	52
	Key Jaicos	18	14	87	52
	North Reef	18	2	87	50
	Chief Channel	17	54	87	55
	Wallis's River, ent.	17	52	88	19
	El Chinchorro I. N. P.	18	58	87	11
	— S. P. of shoal	18	19	87	6
	Misteriosa I.	18	38	85	25
	Viciosi I.	18	00	84	44
	Santanilla or Swan I.	17	21	84	4
	South Keys, N. P.	17	30	87	12
	— Hat Key, S. P.	17	00	87	8
	Longcriffe, or Glover's Reef, S. P.	16	21	87	41
	Sapotillas Keys, S. E. P.	16	00	88	12
Honduras.	Rattan I. E. P.	16	24	86	20
	— W. P.	16	13	86	57
	Guanaja or Bonacca I.	16	32	86	7
	Point Manabique	15	39	88	29
	Omoa	15	37	87	57
	Point Sal	15	47	87	29
	Triunfo de la Cruz	15	41	87	17
	Utilla I. N. P.	16	00	87	2
	Truxillo	15	53	86	6
	Cape Delegado, or Honduras	16	00	86	11
	Cape Cameron	16	2	85	10
	Cape False	15	14	83	3
	Cape Gracios a Dios	14	57	82	46
	Caxones, W. P.	16	2	83	11
	— S. E. P.	15	41	82	27
	Cayman or Vivorilla	15	46	83	26
	Key John Thomas	15	23	81	49
	Alagarte Alla, N. W. P.	15	21	82	5
	— S. E. P.	15	5	81	54
	Serranila	16	5	80	9
	Serrana or Pearl I. N.P.	14	46	79	47
	— S. P.	14	23	79	51
	Guana Reefs, N. P.	14	49	80	44
	— S. P.	13	59	80	41
	Roncador	13	39	79	46
	Musketeers	13	27	79	46
Mosquitos.	Providence I. N. P.	13	27	80	39
	Musquito Keys, N. P.	14	49	82	19
	Ned Thomas' Keys, S. P.	14	12	82	21
	Bracman's Bluff	13	51	82	50
	Man of War Keys	13	4	82	39
	Little Corn Island	12	19	82	6
	Great Corn Island	12	10	82	11
	Bluefields, ent.	11	50	82	54
	I. St. Andrew, mid.	12	33	81	00
	E. S. E. Keys	12	22	80	41
	S. S. W. Key, or Alburquerque	12	6	81	8
	Paxoro Bovo	11	20	82	48
	St. John's Point	10	41	82	54
	Port Boco Toro	9	29	82	5
Panama.	I. Escudo, N. P.	9	14	80	57
	River Chagre, ent.	9	20	80	3

		Lat. D.	Lat. M.	Long. D.	Long. M.
	PORTO BELLO	9	33N	79	35W
	Farallon I. N. P.	9	40	79	33
	Point Manzanillo	9	38	79	20
Darien.	Point St. Blas	9	33	78	40
	Point Conception	9	19	77	53
	Isle of Pines	8	55	77	39
	Cape Tiburon	8	40	77	29
	River Suniquilla, ent.	7	57	76	54
	Point Carabana	8	37	76	57
	Point Arboletes	8	49	76	32
Carthagena.	Island Fuerte	9	20	76	13
	I. St. Bernerd, N. W. P.	9	48	75	50
	CARTHAGENA	10	25	75	29
	Galera de Samba	10	48	75	20
	West ent. River Magdalen	11	3	74	56
	St. Martha	11	15	74	11
	Cape Aguja	11	21	74	12
	Bank Navio quebrado	11	36	73	11
	Hacha	11	31	72	56
	Cape la Vela	12	11	72	14
	Point Galinas	12	27	71	41
Maracaybo.	Monges Islands, N. P.	12	31	70	59
	Cape Chichibacoa	12	17	71	17
	Point Espada	12	5	71	8
	St. Carlos	11	3	71	12
	MARACAYBO	10	43	71	17
	Coro	11	24	69	46
	Point Cardon	11	35	70	20
	Point Macolla	12	6	70	19
	Cape St. Roman	12	12	70	7
	Island Oruba, N. W. P.	12	38	70	9
	— S. E. P.	12	25	69	58
	Point Aricula	11	57	69	53
	Point Savannos	11	33	69	10
	Point Soldado	11	14	68	35
	Key Borrocho	10	57	68	19
	Tucacas	10	51	68	17
	PORTO CABELLO	10	29	68	4
	Valencia	10	18	68	7
	Point St. John Andres	10	30	67	48
Carraccas.	Point Oricaro	10	34	67	17
	Point Trinchera	10	38	67	4
	LA GUIRA	10	37	66	59
	CARRACCAS	10	30	66	57
	Centinela I. or White Rock	10	50	66	6
	Cape Codera	10	36	66	3
	Curacoa I. N. P.	12	24	69	13
	— S. E. P.	12	2	68	46
	Little Curaco	11	59	68	41
	Buenayre, N. P.	12	21	68	26
	— S. P.	12	2	68	18
	Birds or Aves I. western	12	00	67	42
	— Eastern	11	58	67	29
	Roca. W. P.	11	51	66	58
	— E. P.	11	51	66	32
	Orchilla I.	11	49	66	5
	Blanca I.	11	52	64	40
	Tortuga I.	10	57	65	19
	Seven Brothers mid.	11	46	64	27
	Margarita, W. P.	11	2	64	28
	— E. P.	11	00	63	50
	I. Cuagua or Pearl I.	10	49	64	14
	Friars I.	11	14	63	48
	I. Sola	11	20	63	38
	Testigos I.	11	24	63	9
	River Orquilla ent.	10	8	65	32

		Lat. D.	Lat. M.	Long. D.	Long. M.
	New Barcelona	10	8N	64	46W
	I. Borracho	10	20	64	48
Cumana.	Sante Fe	10	16	64	31
	Cumana	10	27	64	15
	Araya	10	35	64	20
	Morro Chocopata	10	42	63	54
	Escondido or Hidden Port	10	41	63	27
	Cape Malapasqua	10	42	63	4
	Cape Three Points	10	46	62	44
	Point Galera	10	45	62	33
	Point Pena or Salina	10	44	61	53
	Dragon's Mouth	10	41	61	48
	River Gaurapiche, ent.	10	12	62	43
	Point Morro	9	54	61	58
	Oronoco River	8	25	60	26
	Cape Barma	8	22	60	4
	Essequebo River	7	00	58	20
	DEMERARA river, ent. Corrobano Point	6	48	57	58
	River Berbice, Ent.	6	20	57	11
	SURINAM River, ent.	5	58	55	15
Surinam.	Paramaribo	5	49	55	15
	R. Marouri, entrance	5	50	53	52
	CAYENNE	4	56	52	15
	Oyapock River, St Louis	3	51	51	40
	Cape Orange	4	12	51	20
	R. Cassipour, entrance	3	54	51	10
	Cape North	1	48	50	10
	Mouth of River Amazon	0	18	50	00
	Cape Magoany	0	17S.	47	56
	Point Tagioca	0	33	47	28
	Para	1	28	47	58
	Bay Maracuno	0	37	47	10
	Caite Harb.	0	47	46	33
	Cape Gurapi	0	42	45	22
	Shoal	0	52	43	40
	Island of St. Joao	1	17	44	13
	Bay of Mt. Luis	1	5	43	18
	Bay de Cabalo de Velha	1	30	43	54
	Point of B. Atius	2	3	43	44
	Itaculumi	2	7	43	50
	S. Marcos	2	27	43	40
	Va. de Alacantra	2	22	43	47
	St. Luis de Maranham	2	29	43	40
	Coroa Grande, or Great Crown Banks, N. E. Point	2	12	43	18
	Fin dos Lancoes Grandes	2	19	42	40
	I. St. Anna	2	18	43	5
	Bay of Rio Perguicas	2	23	42	4
	Iquarasu ent. Parnhaiba	2	44	41	20
	Jericoacoara	2	44	40	15
	Coras de Caracu	2	48	39	41
	Mount Melancias Point	3	7	39	7
	Searra	3	32	38	27
	Bay Iguape	3	40	38	14
	Roccas (dangerous)	3	52	33	26
	St. Lorenzo	3	57	37	52
	Point Daniel	4	42	37	24
	Baxos de Salino	4	40	37	00
	Point Pedras	4	52	36	38
	Cape St. Roque	5	8	35	38
	River Parahiba, ent.	6	48	35	10
	I. Tamarica	7	46	34	57
	Pernambuco	8	11	35	2
	Cape St. Augustine	8	29	34	51
	Rio St. Francisco	10	57	36	4

		Lat. D.	Lat. M.	Long. D.	Long. M.
	ST. SALVADOR (Cape St. Antonio) .	13	1S.	38	32W
	I. das Ilhos .	14	52	38	50
	Porto Seguro .	16	40	39	00
	Abrohlos Islands	18	00	38	22
	Espiritu Santo .	20	11	39	38
	Cape St. Thomas	21	59	40	40
	St. Ann's Islands	22	22	41	46
	John's Is. St. Ann's Bay	22	35	42	5
	Anchor Island .	22	44	41	50
Brazil.	CAPE FRIO .	23	1	42	6
	Monks Islands .	22	59	42	29
	Point Negra .	23	00	42	41
	Maurice Islands .	23	2	42	56
	Razor I. off R. Janeiro	23	5	43	16
	Point St. Cruz .	22	57	43	16
	RIO JANEIRO harb. .	22	52	43	18
	Sugar Loaf .	22	58	43	17
	River Guaratiba .	23	10	43	39
	Point Maranbaya .	23	17	43	58
	I. Grande S. P. .	23	22	44	9
	Point Joantinga .	23	27	44	22
	I. St. Sebastian, N. P.	23	36	45	2
	— S. P. . . .	23	52	45	2
	Mount Trigo .	23	59	45	4
	St. Catherine's Island .	27	32	48	00
	Porto St. Pedro .	32	9	52	2
	Cape St. Mary .	34	39	53	58
	I. Lobos . . .	35	2	54	42
	Maldonado harbour	34	56	54	50
	Point Piedras .	35	29	57	2
R. Plate.	MONTE VIDEO	34	54	56	4
	BUENOS AYRES	34	37	58	24
	Cape St. Antonio	36	21	56	45
	Cape Lobos .	36	55	56	47
	Cape Corientes .	37	59	57	39
	Point de Neuva .	42	55	64	9
	St. Helena . .	44	30	65	27
	St. George's Bay, C. Cordova . .	45	45	67	25
	Cape Blanco .	47	15	65	57
	Point Desire .	47	45	66	2
	Port St. Julian, ent. .	49	7	67	42
	St. Cruz harbour	50	19	68	29
	Cape Fairweather :	51	34	68	59
	Cape Virgins, northern point of entrance to Magellan's Straits .	52	24	68	25
	Cape Espirito Santo (south point of entrance to do.) .	52	40	68	26
	Terra del Fuego C. Penas	53	45	67	29
	— Cape St. Diego .	54	37	65	5
	Staten Land . .				
Terra del Fuego.	— C. St. John, easternmost land near C. Horn . . .	54	48	63	42
	— C. St. Bartholomew	54	57	64	39
	— C. del Medio entr. to Le Maire's Straits	54	49	64	48
	New Island E. part .	55	17	66	25
	Evout's Island, middle	55	32	66	47
	Bernabelas Islands, E.P.	55	44	66	46
	CAPE HORN, South part of Hermit's Isl.	55	58	67	21

IV. *West Coast of America from Cape Horn to Icy Cape.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	CAPE HORN .	55	58S.	67	21W
Terra del Fuego.	I. Diego Ramirez S.part	56	32	68	36
	— N. part .	56	25	68	45
	I. St. Ildefonso S. P. .	55	56	69	17
	Terra del Fuego .				
	— False Cape Horn .	55	42	68	8
	— Yorkminster .	55	27	70	4
	— C. Gloucester. .	54	7	73	35
	— Cape Pillars S. W. entrance to Magellan's Straits .	52	45	74	57
	Evangelist I. W. entr. Magellan's Straits .	52	34	75	5
	Cape Victory .	52	25	74	57
	Cape St Jago .	50	54	75	30
	Cape Three Points	49	46	75	45
	Cape Corso .	49	26	75	45
	I. Campana N. W. point	48	00	75	19
	Cape Tres Montes .	46	59	75	27
	Cape Taitaohaohuon .	45	51	75	28
	I. Huafo W. part .	44	00	74	42
	P. Quilan . .	43	41	74	21
	P. St. Carlos .	41	49	73	53
	P. Quedal . .	41	5	74	9
	P. de la Galera .	39	54	73	46
	VALDIVIA, entrance .	39	51	73	33
	P. Tirua . .	38	29	73	46
	I. de la Mocha W. part	38	20	74	5
	St. Maria Islands N. P.	36	59	73	41
Coast of Chili.	— S. P. . . .	37	5	73	42
	CONCEPTION, city .	36	49	73	9
	Talcahuano, port of do.	36	41	73	12
	Santiago . . .	33	27	70	43
	VALPARAISO, port .	33	1	71	37
	Point Ballena .	31	50	71	44
	Coquimbo . .	29	56	71	19
	Huasco . .	28	26	71	15
	Copiapo . .	27	10	71	8
	P. Negra . .	26	24	70	56
	Isl. St. Felix, Eastern .	26	20	79	47
	— Western .	26	16	80	3
	I. Blanca . .	24	56	70	36
	Morro Moreno .	23	18	70	32
	Morro de Mexilones .	23	4	70	28
	Point Tames .	22	33	70	10
	Jaguey de Raquisa	21	50	70	9
	Pavellon de Pica .	20	58	70	16
	Point Piedras .	20	5	70	13
	Point Pisagua .	19	26	70	19
	Aricà . .	18	27	70	19
	Point de Coles .	17	42	71	14
	Ilo . . .	17	38	71	13
	Point Cornejo .	16	41	72	46
Peru.	Cumana . .	16	17	73	21
	Atico . .	16	8	73	47
	R. St. Juan .	15	15	75	14
	Los Amigos Point	14	27	76	2
	Pisco . .	13	46	76	12
	Caneta . .	13	1	76	27
	P. Chilca . .	12	33	76	43
	I. St. Lorenzo, W. P.	12	5	77	8
	LIMA . . .	12	3	76	55
	CALLO, sea port of Lima . . .	12	2	77	4
	I. Pescador, W. part .	11	46	77	10

		Lat.		Long.	
		D.	M.	D.	M.
	Los Hormigas Islands	11	56S.	77	48W
	I. Pelada	11	27	77	41
	Island St. Martin	11	3	77	30
	Point Santander	10	39	77	41
	Rock seen in 1792	10	48	78	48
Peru.	Ferrol (entrance)	9	7	78	30
	Truxillo	8	8	78	53
	I. Malabrigo (port)	7	48	79	21
	Isl. Lobos de Mer	6	58	80	44
	Isl. Lobos de Tierre	6	24	80	46
	Eten	6	56	79	49
	Point de Ajuga	5	59	81	4
	Point Payta	5	3	81	2
	Cape Blanco	4	19	81	6
	P. Malpelo	3	32	80	17
	GUAYAQUIL City	2	12	79	42
	I. Puna, S. W. P.	3	4	80	8
	Point St. Helena	2	10	80	48
	I. Pelado	1	56	80	36
	Point del Callo	1	23	80	34
	I. de la Plata, W. P.	1	18	80	57
	Cape St. Lorenzo	1	4	80	43
	Manta	0	57	80	32
Quito.	Cape Pasado	0	27	80	20
	Quito	0	18	78	18
	Arbol	0	15N	79	48
	Cape St. Francisco	0	39	79	52
	P. de la Galera	0	48	79	51
	R. Esmeraldas entrance	0	58	79	23
	P. Mangles	1	37	78	52
	I. Tumaco	1	47	78	38
	P. Guascama	2	29	78	23
	I. Gorgona middle	2	53	78	7
	River Cajambrie, ent.	3	19	77	3
	I. de Malpelo	3	55	80	4
	I. de Palmas	3	57	77	7
	P. Chirambira	4	13	77	15
	Cape Corientes	5	34	77	15
	Limones	6	3	77	11
Panama.	P. St. Francisco Solano	6	49	77	47
	P. Garachine	8	8	78	12
	PANAMA	8	57	79	22
	P. Mala	7	24	79	53
	Peurcos Point	7	13	80	18
	I. Quibo, N. P.	7	41	81	37
	Los Ladrones	7	52	82	30
	Point Burica	8	3	82	50
	Gulfe Dulce, W. P.	8	23	83	18
	I. Cano ent. off English harbour	8	48	83	51
	Cape Herradura	9	37	84	21
	Cape Blanco	9	28	84	41
	Nicoya	9	42	84	57
	Morro Hermoso	9	45	85	5
	P. St. Catharine	10	28	85	42
	St. John's Har.	11	22	85	44
	Point Desolado	11	49	86	40
	Leon	12	22	86	46
	Realejo	12	27	87	5
	Aserradores	12	35	97	20
	Point Cosignina	12	53	87	37
	Point Candadillo	13	7	87	57
	Sacatecoluca	13	26	88	47
	Point Remedios	13	30	89	42
	P. Gautimala	13	54	90	53
	Puerto Ventosa	16	6	95	22

		Lat.		Long.	
		D.	M.	D.	M.
	Agualco	16	2N.	96	52W
	ACAPULCO	16	55	100	54
	Cape Corientes	20	32	105	35
	St. Blas	21	30	104	50
	Tres Marias	21	28	106	29
	St. Joseph	23	4	109	42
	Cape St. Lucas	22	44	109	54
	Morro Hermosa	27	46	114	41
	Redondo Island	29	49	115	10
	Bay St. Francisco	30	23	115	36
	B. Todos Santos	31	46	116	22
	Port Diego	32	39	116	59
	Point Conception	34	32	120	6
	Monterey	36	38	121	43
	Port St. Francisco	37	49	122	14
	Cape Mendocino	40	19	124	7
	Port Trinidad	41	3	123	54
	Cape Blanco or Orford	42	53	124	25
	Cape Gregory	43	26	124	6
	Cape Foulweather	44	52	124	00
	Cape Rond	45	43	123	48
	Cape Disappointment	46	19	123	59
	Cape Flattery	48	24	124	31
	Breaker's Point	49	24	126	26
North West Coast of America.	NOOTKA	49	36	126	20
	Woody Point	50	6	127	43
	Bay St. Louis	50	34	128	14
	Isles de Sartine (or Scott)	50	56	128	50
	Cape Scott	50	48	128	20
	Cape Caution	51	12	127	52
	Cape Hector or James	51	57	131	7
	Bay de la Touche	52	42	132	10
	Cape Henry	52	53	132	27
	Bay de Clouard	53	52	133	21
	Point North	54	20	133	15
	Cape St. Bartolomo	55	12	133	38
	Cape Ommaney	56	12	134	35
	Port Guibert	56	38	135	00
	Port Neckar	56	43	135	4
	C. Engano or Edgecumb	57	2	135	50
	Port Gaudaloupe	57	10	135	43
	Port de los Remedios	57	24	135	43
	Cape Cross	57	57	136	24
	Port des Francais	58	37	137	20
	Cape Fairweather	58	55	137	52
	Behring's Bay	59	18	139	00
	Point de la Boussole	59	50	140	55
	Mount St. Elias	60	23	140	45
	Cape Hinchingbroke	60	15	146	16
	Cape Elizabeth	59	9	151	28
	Barren Isles	59	00	151	46
	Point Banks	58	41	152	6
	Cape Douglass	58	56	152	50
	Cape Whitsunday	58	15	151	46
	Cape Grenville	57	33	152	00
	Trinity Islands	56	36	153	40
	Foggy Island	56	10	156	45
	Halibut Head Island	54	27	162	30
	Ounalashka Island, N.P.	53	55	166	12
	Bristol R. entrance	58	12	157	33
	Round Island	58	29	159	53
	Cape Newnham	58	34	161	55
Behring's S.	Shoalness	60	00	161	52
	Cape Stephens	63	33	162	17
	Cape Denbigh	64	17	161	53
	Cape Rodney	64	34	166	37

	Lat. D. M.	Long. D. M.
Cape Prince of Wales .	65 45N.	168 17W
Cape Mulgrave .	67 45	165 12
Cape Lisburne .	69 5	165 22
ICY CAPE .	70 29	161 42

V. *From the River St. Croix to Cape Cansor.*

	Lat. M. D.	Long. D. M.
Entrance of St. Croix River . . .	45 7N.	67 8W
Mocgone's I. (entrance of St. John's River) .	45 18	66 4
Cape Spencer .	45 17	65 52
C. Chignecto (entrance Bason of mines) .	45 24	64 49
Haute Island .	45 19	64 51
Annapolis Royal .	44 47	65 50
Breyer's Island .	44 19	66 25
St. Mary's Cape .	44 10	66 8
Cape Fourchu .	43 52	66 4
Seal Isles . .	43 27	65 55
CAPE SABLE .	43 26	65 32
Sable Island E. point	44 5	60 3
— W. ditto . .	44 3	60 31
Port Roseway .	43 40	65 13
Port Mansfield .	43 50	64 52
Gambier Harbour	44 00	64 41
LIVERPOOL .	44 5	64 40
Isle of Hope .	43 53	64 39
Port Jackson .	44 13	64 27
Charlotte Bay .	44 34	63 53
C. Sambro light-house .	44 30	63 32
HALIFAX Harbour	44 36	63 28
Port Stephens .	45 00	61 59
Sandwich Bay .	45 8	61 36
Torbay . . .	45 12	61 16
Port Howe . . .	45 13	61 6
CAPE CANSOR .	45 18	60 56

VI. *The Gulf of St. Lawrence.*

	Lat. D. M.	Long. D. M.
Chedabucto Bay .	45 23N.	61 00W
Gut of Cansor, S. ent.	45 28	61 13
Cape Hinchinbroke	45 34	60 40
Cape Portland .	45 48	60 3
LOUISBURGH .	45 54	59 55
CAPE BRETON	45 57	59 48
Scattery Island .	46 1	59 41
Flint Island . .	46 9	59 48
Spanish Bay .	46 18	60 10
Port Dauphin .	46 23	60 30
Cape North Island	47 6	60 28
Cheticun Harbour	46 42	60 58
Sea Wolf Island .	46 27	61 12
Port Hood . .	45 58	61 35
Justan Corp Island	45 56	61 37
GUT OF CANSOR, North entrance	45 42	61 27
Cape St. George or St. Lewis . . .	45 52	61 55
Picton Island .	45 51	62 27
Cape Tormentine	46 9	63 36
Richibucto Harbour .	46 44N.	64 36W
St. John's I. (N. Cape).	47 5	63 45
West Point . .	46 37	64 10
Cape Egmont .	46 28	63 51
Halifax Bay .	46 25	63 36
East Point . .	46 27	61 48
Bear Cape . .	46 3	62 12
Hilsborough Bay .	46 6	62 55
P. Escuminac .	47 3	64 33
Miscou I. (entrance of Chaleur Bay) .	48 3	64 15
Cape Despair .	48 27	63 58
Island Bonaventure	48 32	63 50
Flat Point . .	48 38	63 50
Cape Gaspe .	48 47	63 52
Cape Rozier .	48 50	63 54
Magdalen River .	49 13	64 42
St. Ann's River .	49 8	66 8
Mount Camille .	48 37	67 45
I. de Bik in the River St. Lawrence .	48 30	68 24
I. of Anticosta, E. P.	49 8	61 40
— Jupiter's River	49 26	63 25
— S. W. ditto .	49 22	63 23
— West ditto .	49 48	64 16
— North ditto .	49 53	63 54
Deadman's Island	47 17	61 58
Entry Island .	47 15	61 24
Amherst Isl. S. W. P.	47 12	61 44
Magdalen Isl. N. E. P.	47 41	61 5
Biron Island .	47 52	61 10
Bird Island . .	47 55	60 46
St. Paul's Island .	47 11	60 4

VII. *Newfoundland.*

	Lat. D. M.	Long. D. M.
Limits of the Great Bank of Newfoundland, N. point . .	50 15N.	49 45W
— South point .	41 00	52 00
Outer Bank .	47 00	45 00
Cape Norman .	51 42	56 00
Seal Islands .	51 22	56 50
Point Ferolle .	51 5	57 11
St. John's Bay .	50 52	57 23
Point Riche . .	50 46	57 28
Ingornechoix Bay	50 39	57 22
Bon Bay . .	49 36	58 5
Cape St. Gregory .	49 22	58 22
South Head . .	49 10	58 33
Cape St. George .	48 30	59 12
Cape Anguille .	48 00	59 18
Cape Ray . .	47 35	59 15
Connor Bay .	47 38	58 00
Burges Island .	47 33	57 37
Rainea Islands .	47 32	57 25
Penguin's Islands .	47 24	57 00
Fortune Head .	47 9	55 51
Burnt Island .	47 16	56 00
Great Miquelon .	47 5	56 24
Langley Island .	46 50	56 24
St. Peter's Island .	46 46	56 15

		Lat. D. M.	Long. D. M.
Newfoundland.	Point May	46 56N.	56 2W
	Chapeau Rouge	46 52	55 25
	Mortier Rocks	47 3	54 57
	Mortier Harbour	47 10	55 3
	Red Island, S. P.	47 24	54 8
	Virgin Rocks	47 11	54 3
	Point Brehin	47 2	54 12
	Cape St. Mary	46 52	54 00
	St. Mary's Bay	46 50	53 40
	Cape Pine	46 44	53 25
	CAPE RACE	46 40	52 54
	Cape Race Rocks	46 30	51 30
	Cape Ballard	46 49	52 42
	Cape Broyle	47 8	52 35
	Bay of Bull	47 21	52 28
	Cape Spear	47 30	52 20
	St. John's Harbour	47 33	52 25
	Cape St. Francis	47 57	52 30
	P. of Grates	48 22	52 32
	Trinity Bay	48 30	52 50
	Cape Bonavista	48 56	52 35
	Barrow Harbour	48 52	53 00
	Punk Island	50 1	52 12
	Cape Freels	49 34	52 55
	Woodham Islands	49 54	53 30
	Gander Bay	49 44	53 55
	Fago Island	50 00	53 54
	Twillingate Islands	50 3	54 35
	Bay of Notre Dame	50 00	55 30
	Cape St. John	50 10	55 30
	Horse Islands	50 24	55 48
	White Bay	50 19	56 15
	Hooping Harbour	50 46	56 13
	Green Island	50 47	55 35
	Groais ditto	50 56	55 38
	Hare Bay entrance	51 17	55 50
	St. Anthony's Cape	51 20	55 36
	St. Lunaire Bay	51 29	55 30
	Cape Degrat	51 43	55 30
	Bell Isle	51 58	55 30

VIII. *From Quebec to Hudson's Bay.*

		Lat. D. M.	Long. D. M.
Canada.	QUEBEC	46 48N.	71 5W
	Coudras Island	47 15	70 19
	St. Paul's Bay	47 16	70 24
	Bay of Rocks	48 00	69 42
	Point Mille Vache	48 45	68 38
	Manicougan Point	49 11	67 42
	Cape Nicholas	49 23	67 10
	Cape Montpelles	49 25	66 51
	Trinity Cove	49 30	66 48
	The Seven Islands Bay	50 10	66 00
	St. John's River	50 20	63 55
	Mingan Island	50 16	63 35
	Eskimaux Islands	50 13	62 55
	Mount Joli	50 5	61 28
	Boat Islands	50 00	60 24
	St. Mary's Islands	50 8	59 50
	Little Mecatina ditto	50 28	59 27
	Great Mecatina Point	50 45	59 8
	St. Augustine Bay	51 15	58 50
	Eskimaux Bay	51 28	57 30
	Grand Point	51 24	57 18
Labrador.	Forteau Bay	51 32N.	57 00W
	Red Cliffs	51 36	56 52
	Black Bay	51 43	56 47
	Red Bay	51 46	56 30
	York Point	51 59	55 58
	Cape Charles	52 13	55 30
	Great Bay of Eskimaux	54 20	57 36
	Cape Harison	54 54	56 50
	St. Peter's Harbour	56 28	60 50
	Inchanted Cape	56 40	60 55
	Saddle Islands	57 13	60 50
	East Island	57 45	61 20
	Steel Point	58 7	61 50
	Cardinal's Island	58 50	63 00
	False Black Head	59 20	63 19
	Black Head	59 50	63 37
	Cape Chidley	60 14	65 20
	Button's Islands	60 47	65 5

IX. *Hudson's Bay and Straits, and Davis' Straits.*

		Lat. D. M.	Long. D. M.
Hudson's and Davis's Bay and Straits.	Cape Resolution	61 29N.	65 16W
	Saddle Back Island	62 7	68 13
	Upper Savage Island	62 32	70 48
	North Bluff	62 34	70 56
	Capes Charles	62 46	74 15
	Cape Dorset	64 50	77 12
	Cape Pembroke	63 00	82 36
	Cape Walsingham	62 39	77 48
	Cape Digges	62 41	78 50
	Salisbury Islands	63 29	76 47
	Mansfield Isl. N. part	62 38	80 33
	— S. part	61 35	81 00
	Cape Southampton	62 10	86 3
	North Sleepers	61 38	79 45
	West Sleepers	60 8	81 36
	Portland Point	59 00	78 30
	Baker's Dozen	58 5	79 30
	Belcher's N. point	56 20	80 15
	James' Bay		
	— Cape Henrietta	55 10	82 30
	— Cape Jones	54 50	78 54
	— Bear Isle	54 34	81 24
	— North Cubb	54 20	80 48
	— The Twins	53 12	80 35
	— Albany Fort	52 14	82 00
	Moose Fort	51 16	80 56
	Charlton Island	52 3	79 55
	York Fort	57 2	92 32
	Cape Churchill	58 48	93 12
	P. of Wales' Fort	58 48	94 14
	Marble Island	62 33	91 6
	Cape Dobbes	65 00	86 42
	Cape Walsingham	64 5	66 10
	Dyer's Cape	65 20	66 15
	Sanderson's Hope	66 18	68 10
	Cape Bedford	66 55	68 30
	Waygate Island	70 40	44 13

X. *Greenland.*

		Lat. D. M.	Long. D. M.
Greenland.	Muskito Cove	64 55N	52 57W
	Gothaah ent. of R. Bal.	64 10	51 47

	Lat. D. M.	Long. D. M.
Bear Sound	63 20N.	49 10W
Maab	62 5	48 27
Cape Farewell	59 38	42 42
Whale's Island	62 30	43 15
Herjoisness	65 3	29 50
Bontokoe Island	73 15	7 5
Gael Hamkes Bay	75 00	6 51
John Mayen's Island	71 10	9 49

XI. *Iceland.*

	Lat. D. M.	Long. D. M.
Cape Reikianess	63 55N.	22 47W
Bessested	64 6	21 54
Mount Suaesell	64 52	23 54
Patrixfiord	65 36	24 10
Straumness	65 40	24 29
North Cape	66 34	22 10
Hola	65 44	19 44
Grim's Island	66 57	19 12
Rikefiord	66 30	17 35
Longnose	66 25	16 19
Enchuisen Island	64 20	14 15
Wreeland ditto	63 55	18 19
Cape Heckla	63 22	19 54
Westman's Island	63 20	20 28

XII. *Spitzbergen.*

	Lat. D. M.	Long. D. M.
South Cape	76 32N	13 45E.
Fair Foreland	78 53	8 45
Amsterdam Isl. (Hackluyt's Head)	79 46	9 49
Smeerenburg Harbour	79 44	9 51
Verlegen Hook	80 7	16 50
Hope Island	76 30	20 28
Bear or Cherry Island	74 52	14 45

XIII. *English Coast from London to St. Mary's Light (Scilly.)*

		Lat. D. M.	Long. D. M.
	LONDON	51 31N.	0 6W
	GREENWICH Obs.	51 29	0 00E.
	Woolwich	51 30	0 4
	Purfleet	51 30	0 19
	Gravesend	51 28	0 22
	Rochester	51 23	0 32
	Sheerness	51 27	0 44
	Nore	51 28	0 51
	N. Foreland light	51 22	1 27
	S. Foreland lights	51 8	1 22
	Deal Castle	51 13	1 24
	DOVER	51 8	1 19
	Dungeness	50 55	0 58
	Hastings	50 53	0 36
	Beachy Head	50 44	0 15
	Brighton	50 50	0 6W
	Shoreham	50 50	0 16
	Arundel	50 53	0 35
	Selsey Bill	50 43	0 48
	Owers light	50 40	0 40
	PORTSMOUTH		
	Town	50 47N.	1 6W
I. Wight.	Isle of Wight		
I. Wight.	— Cowes	50 46	1 16
I. Wight.	— Bembridge Ledge or Point	50 41	1 3
I. Wight.	— Dunnose	50 37	1 11
I. Wight.	— St. Catharine's Pt.	50 35	1 18
I. Wight.	— Needle's lights	50 40	1 34
South Coast of England.	Hurst light	50 42	1 33
South Coast of England.	Poole Harbour	50 40	1 59
South Coast of England.	St. Aldan's Head	50 33	2 5
South Coast of England.	Weymouth	50 36	2 27
South Coast of England.	Portland lights	50 31	2 27
South Coast of England.	Exmouth Bar	50 38	3 21
South Coast of England.	Torbay, Berry Head	50 24	3 28
South Coast of England.	Dartmouth	50 18	3 33
South Coast of England.	Start Point	50 13	3 38
South Coast of England.	Praul's ditto	50 13	3 42
South Coast of England.	Bolt Head	50 13	3 48
South Coast of England.	Eddystone light	50 11	4 15
South Coast of England.	Hand Deeps	50 13	4 19
South Coast of England.	Ram Head	50 19	4 13
South Coast of England.	PLYMOUTH	50 22	4 10
South Coast of England.	Fowey	50 20	4 38
South Coast of England.	Deadman's Point	50 13	4 47
South Coast of England.	Falmouth	50 8	5 3
South Coast of England.	Manacles Rocks	50 2	5 1
South Coast of England.	Black Head	50 1	5 4
South Coast of England.	LIZARD Point	49 58	5 11
South Coast of England.	Mount's Bay	50 8	5 30
South Coast of England.	Penzance	50 12	5 33
South Coast of England.	Runnel's Stone	50 4	5 42
South Coast of England.	Wolf Rock	49 58	5 56
South Coast of England.	Land's End	50 9	5 48
South Coast of England.	St. Agnes light (Scilly)	49 54	6 19
South Coast of England.	St. Mary's ditto	49 55	6 17
South Coast of England.	St. Martin's	49 58	6 15

XIV. *French Coast from Calais to Ushant.*

		Lat. D. M.	Long. D. M.
	CALAIS	50 58N.	1 51E.
	Cape Griz Nez	50 52	1 34
	Ambleteuse	50 48	1 36
	BOULOGNE	50 44	1 37
	Etaples	50 31	1 39
	Montreul	50 28	1 45
	La Rochelle	50 19	1 40
	Abbeville	50 7	1 50
	Grotoy	50 13	1 38
	St. Vallery, R. Somme	50 11	1 36
	Dieppe light	49 56	1 4
	St. Valley, R. Caux	49 52	0 41
	Fecamp	49 46	0 22
North Coast of France.	Cape de Caux	49 41	0 11
North Coast of France.	Cape de le Heve	49 31	0 3
North Coast of France.	HAVRE DE GRACE	49 29	0 6
North Coast of France.	PARIS Obs.	48 50	2 20
North Coast of France.	Mouth of Seine	49 27	0 3
North Coast of France.	Harfleur	49 30	0 11
North Coast of France.	Honfleur	49 25	0 14
North Coast of France.	Caen	49 11	0 21W
North Coast of France.	Bayeux	49 16	0 43
North Coast of France.	Carentan	49 18	1 16

North Coast of France.

	Lat. D.	Lat. M.	Long. D.	Long. M.
St. Marcou Island	49	30N.	1	10W
Cape Barfleur Light	49	42	1	16
CHERBOURGH	49	38	1	37
Pelee Island	49	40	1	36
Cape la Hogue	49	45	1	56
Alderney I. N. point	49	46	2	12
Caskets lights	49	46	2	26
Guernsey I. W. point	49	26	2	43
Sark I. N. point	49	26	2	23
Jersey Island				
— Cape Grosness	49	18	2	19
— St. Aubin	49	13	2	11
— St. Clement's point	49	9	2	00
I. de Chausey	48	52	1	50
Coutances	49	3	1	27
Granville	48	50	1	36
Avranches	48	41	1	22
Mount St. Michael	48	38	1	33
Pontorson	48	33	1	32
St. Malo	48	39	2	1
Cape Frehel light	48	41	2	21
St. Brieux	48	31	2	42
Brehat Island	48	50	2	56
Tregueir	48	47	3	15
Morlaix	48	35	3	53
St. Pol de Leon	48	41	4	00
I. de Bas	48	46	4	2
Roche Blanche	49	1	3	58
St. Anthony's lights	48	40	4	29
USHANT, W. point	48	29	5	3

XV. *From the North Foreland to Duncansbay Head.*

East Coast of England.

	Lat. D.	Lat. M.	Long. D.	Long. M.
North Foreland	51	23N.	1	27E.
Kentish Knock	51	41	1	40
Long Sand Head	51	45	1	38
Galloper, N. point	51	52	2	5
— S. point	51	41	2	1
Shipwash, N. point	52	00	1	36
— S. point	51	53	1	33
Gaberd, outer	51	58	1	59
Orfordness	52	5	1	30
Aldboro' Knaps	52	7	1	40
Southwold	52	20	1	39
Leostoff lights	52	29	1	46
Yarmouth	52	37	1	44
Winterton Ness lights	52	43	1	43
Smith's Knowl	52	54	2	20
Hasborough Sand, S. P.	52	51	1	48
— N. P.	53	2	1	35
Sherringham Shoals	53	3	1	20
Hasborough lights	52	49	1	34
Cromer lights	52	56	1	26
Lemon and Ower, N. P.	53	14	1	58
— S. P.	53	8	2	00
Cromer Bank	53	11	1	35
Dudgeon light	53	15	1	9
Outer Dowsing	53	33	1	14
Inner Dowsing	53	15	0	44
Lynn Knock	53	3	0	29
Spurn lights	53	38	0	20
Flamborough Head	54	9	0	6
Filey Brig	54	15	0	1W
Scarborough	54	18N	0	10W
Robin Hood's Bay	54	27	0	20
Whitby	54	31	0	26
River Tees' Mouth	54	41	1	2
Stockton	54	38	1	8
River Tyne's Mouth lights	55	6	1	15
Coquet Island	55	22	1	21
Staples light	55	39	1	40
Fern light	55	38	1	42
Sunderland point	55	36	1	43
Holy Island	55	42	1	50
BERWICK	55	47	2	3

East Coast of Scotland.

	Lat. D.	Lat. M.	Long. D.	Long. M.
St. Abb's Head	55	57	2	6
DUNBAR	56	00	2	29
May Island lights	56	11	2	32
The Bass	56	5	2	36
N. Berwick	56	4	2	41
EDINGBURGH	55	57	3	12
Ellyness	56	11	2	44
Fife Ness	56	17	2	33
St. Andrew's	56	21	2	45
Mouth of Tay	56	27	2	38
Bell Rock, off ditto	56	27	2	22
Buttonness lights	56	28	2	41
Red Head	56	37	2	24
Montrose	56	44	2	23
Tod Head	56	51	2	14
NEW ABERDEEN	57	9	2	8
Newburgh	57	20	2	3
Peter Head	57	32	1	44
Buchan Ness	57	29	1	43
Ratrie Head	57	38	1	46
Kinnaird's Head	57	42	1	56
Bamff	57	41	2	27
Fort St. George	57	38	4	00
Inverness	57	32	4	10
Cromatrie	57	43	3	58
Tarbet Ness	57	54	3	44
Clythness	58	20	3	8
Noss Head	58	29	3	6
Duncansbay Head	58	40	3	8

XVI. *The Orkney Islands.*

Orkney Islands.

	Lat. D.	Lat. M.	Long. D.	Long. M.
Pentland Skerries	58	43N	3	3W
Stromo	58	43	3	14
South Ronaldsha, S. P.	58	44	3	5
Copinsha	58	54	2	47
Lam's Head on Stromsa Island	59	4	2	40
North Ronaldsha, N. P.	59	23	2	31
Mould Head, on Papa Westra Island	59	21	3	2
Noup Head, on Westra Island	59	18	3	14
Marwick Head, on Pomona Island	59	6	3	28
Stromness	58	57	3	26
Hoy Head, on Hoy Wells Island	58	55	3	31
Slue Skerry	59	3	4	16
Fair Island	59	29	1	47

XVII. *The Shetland Islands.*

		Lat. D. M.	Long. D. M.
Shetland I.	Sunbro Head, S. point	59 49N.	1 20W
	Rose or Hangcliff	60 13	0 40
	Brassa Sound, Lerwick	60 11	1 00
	Out Skerries	60 37	0 8
	Whalsey Isle	60 32	0 32
	Ulst Island, N. E. P.	61 7	0 15
	Foul Island	60 8	2 16

XVIII. *Ferro Islands.*

		Lat. D. M.	Long. D. M.
Ferro I.	The Monk Rock appears like a ship under sail	61 15N.	6 47W
	Fucloe I. (N. E. part of Ferro)	62 15	6 2
	East point of Mygenes Island, N. W. part of Ferro Islands	62 3	7 32

XIX. *From Duncansbay Head to the Land's End.*

		Lat. D. M.	Long. D. M.
	Duncansbay Head	58 40N.	3 8W
	Dunnet Head	58 43	3 29
	Farout Head	58 38	5 00
	Cape Wrath, or Barre Head	58 36	5 20
	A Rock seen at ¾ Ebb	58 45	5 21
	Rona Island	58 55	6 15
N. and W. Coast of Scotland.	*Rockal*	57 42	14 6
	St. Kilda	57 51	8 56
	Butt of the Lewis	58 29	6 34
	Gallen Head	58 10	7 10
	Flannen Islands	58 13	7 30
	Hyskere Island	57 23	7 38
	South Ulst Island	57 8	7 10
	Mingalay Island	56 48	7 33
	Rea Head	57 50	5 44
	Cana Islands	57 3	6 38
	Helsker Island	56 56	6 38
	Rum I. W. P.	56 59	6 26
	Tirey Island, S. P.	56 30	6 52
	Coll I. North P.	56 42	6 25
	Skerryvore	56 17	7 2
	Illa Island, S. W. P.	55 47	6 24
	— South P.	55 39	6 10
	Mull of Cantire light house	55 20	5 37
	I. of Arran, S. E. part	55 31	4 57
	Cumray I. entrance of Clyde	55 47	4 48
	GLASGOW	55 52	4 16
	Elsa Island	55 20	4 55
	Irwin	55 39	4 30
	Air Light	55 26	4 28
	Loch Ryan	55 3	5 00
	Port Patrick Light	54 48	4 58
	Mull of Galloway	54 37	4 45
	Great Scar Island	54 40	4 36
	Burrow Head	54 41	4 16
	Solway Firth	54 47N.	3 25W
	CARLISLE	54 54	2 44
	—		
	St. Bee's Head Light	54 30	3 30
	White Haven	54 32	3 22
	Selker Rock	54 16	3 19
	Lancaster	54 2	2 41
	Formby Point	53 32	2 58
	LIVERPOOL	53 22	2 52
	Point of Air Light	53 20	3 11
	Great Orms Head	53 20	3 43
	Point Linas Light	53 24	4 11
West Coast of England.	Skerries Light	53 24	4 30
	Holyhead, W. P.	53 18	4 32
	Branchy Pool Head	52 47	4 37
	Bardsey Island	52 44	4 38
	Barmouth	52 43	3 52
	Aberiswith	52 23	3 53
	Cardigan Harbour	52 6	4 38
	Strumble Head	52 1	5 10
	St. David's Head	51 55	5 20
	Ramsay Island	51 52	5 22
	Small's light house	51 45	5 36
	St. Ann's ditto, Milford Haven	51 41	5 10
	St. Gowan's Head	51 38	4 58
	Caldy Island	51 40	4 40
	Worm's Head	51 34	4 17
	Mumble's Point & light	51 34	3 57
	Nash Point	51 26	3 33
	BRISTOL	51 27	2 35
	Flatholm light	51 23	3 6
	Lundy Island, entrance of Bristol Channel	51 10	4 38
	Mort P. entrance of Bristol Channel	51 11	4 12
	Hartland Point	51 1	4 30
	Padstow	50 35	4 54
	Cow and Calf	50 33	5 5
	Towan Head	50 25	5 9
	St. Ive's Bay	50 13	5 28
	Cape Cornwall	50 8	5 41
	The Seven Stones	50 2	6 6
	The Wolf Rock	49 53	5 51
	The Land's End	50 4	5 42

XX. *Ireland.*

		Lat. D. M.	Long. D. M.
	CAPE CLEAR	51 22N.	9 37W
	Fastnet Rock	51 19	9 44
	Crook Haven	51 26	9 52
West Coast of Ireland.	Mizen Head	51 25	10 2
	Sheep's Head	51 33	10 5
	Bantry Bay	51 36	10 10
	Grelagh Rocks	51 31	10 30
	Dursey I. W. P.	51 37	10 36
	Bull Rock	51 38	10 42
	Cow ditto	51 37	10 39
	Cod's Head	51 42	10 27
	Kenmare Bay	51 44	10 30
	Lamb's Head	51 47	10 28
	Hog Islands	51 48	10 38
	Hog's Head	51 50	10 36
	Bolus Head	51 52	10 44

		Lat. D. M.	Long. D. M.
West Coast of Ireland.	Skelling's Rocks .	51 52N.	11 00W
	Lemon Rock .	51 53	10 53
	Bray Head . .	51 58	10 50
	Dingle Bay . .	52 5	10 50
	Foze Rock . .	52 6	11 6
	Ferriter's Island .	52 8	11 1
	Tiraght Rocks .	52 10	11 4
	Great Blasket .	52 11	10 59
	Ennis Tuscan .	52 14	11 00
	Dunmore Head .	52 12	10 53
	Dunorling Head .	52 19	10 49
	Brandon Head .	52 23	10 36
	The Seven Hogs Rocks	52 26	10 31
	Kerry Head, S. entrance of Shannon River	52 30	10 24
	Loop Head, N. entrance ditto . .	52 37	10 23
	LIMERICK .	52 42	9 12
	Clare . . .	52 51	9 32
	Hag's Head .	53 5	9 43
	North Arran or Killaney	53 18	10 4
	Galway Bay .	53 17	9 49
	Slime Head .	53 35	10 32
	Ennis Shark I. .	53 46	10 36
	Ennis Turk I. .	53 52	10 21
	Clare Island .	53 58	10 14
	Achil Head .	54 7	10 30
	Black Rock .	54 13	10 36
	Urris Head .	54 28	10 18
North Coast of Ireland.	Broad Haven .	54 26	10 12
	Tuns Rocks, off Broad Haven . .	54 31	10 4
	Down Patrick Head	54 27	9 36
	Killala . .	54 19	9 27
	Sligo Bay . .	54 24	8 58
	Ennis Murray Island	54 32	8 57
	Donnegal Bay .	54 38	8 50
	Tillen Head .	54 42	8 59
	Arranmore .	55 2	8 38
	Bloody Foreland .	55 10	8 16
	Tory Island .	55 17	8 16
	Hoar Head . .	55 14	7 57
	Mulroy . .	55 17	7 48
	Loch Swilley .	55 18	7 33
	Mallin Head .	55 24	7 24
	Ennistrahul Rocks light	55 28	7 14
	Inishone Head, entrance of Londonderry	55 16	6 54
	LONDONDERRY	55 00	7 15
	Giant's Causeway	55 16	6 26
	Racklin I. W. point	55 20	6 16
	Fair Head .	55 15	6 6
	Torr Point . .	55 14	6 1
East Coast of Ireland.	The Maid's Rocks	54 57	5 39
	Black Head .	54 45	5 38
	Carrickfergus .	54 43	5 46
	BELFAST . .	54 35	5 57
	Belfast Loch .	54 43	5 35
	Mew Island lights	54 41	5 24
	South Rock light .	54 21	5 24
	Dundrum . .	54 13	5 51
	Carlingford Lock	54 00	6 4
	Dundalk . .	53 59	6 20
	Drogheda Bar .	53 45	6 14

		Lat. D. M.	Long. D. M.
E. C. of Ireland.	St. Patrick's Island	53 36N.	6 2W
	Lambay Island .	53 29	5 59
	Howth Head light	53 22	6 2
	DUBLIN . .	53 22	6 17
	WICKLOW lights	52 59	6 1
	Arklow . .	52 49	6 6
	Glasscarrick .	52 36	6 11
South Coast of Ireland.	WEXFORD .	52 21	6 28
	Tusker Rock .	52 12	6 8
	Carnsore Point .	52 11	6 19
	The Saltees Rocks	52 6	6 36
	Hook light, Waterford harbour . .	52 5	6 56
	Dungarven . .	52 3	7 36
	Helwick Head .	52 00	7 31
	Youghall . .	51 55	7 49
	CORK Harbour .	51 47	8 11
	Kingsale Harbour	51 38	8 29
	Old Head of Kingsale lights . .	51 35	8 30
	Seven Heads .	51 34	8 40
	Dundedy Head .	51 32	8 56
	The Stags, off Toe head	51 27	9 16
	BALTIMORE harbour	51 27	9 26
	XXI. *The Isle of Man.*		
		Lat. D. M.	**Long. D. M.**
I. of Man.	Calf of Man .	54 2N.	4 42W
	Douglass . .	54 9	4 24
	Ramsey Bay .	54 19	4 16
	Point of Air .	54 25	4 18
	Peel Hill . .	54 12	4 37
	Castletown . .	54 3	4 35
	XXII. *From Calais to the Scaw.*		
		Lat. D. M.	**Long. D. M.**
N. of France.	CALAIS . .	50 58N	1 51E.
	Gravelines . .	50 59	2 8
	DUNKIRK .	51 2	2 22
	Nieuport . .	51 8	2 45
	OSTEND . .	51 14	2 55
	Sluys . . .	51 19	3 23
	ANTWERP .	51 13	4 24
Holland.	Walcheren I. W. P.	51 32	3 28
	— Flushing .	51 27	3 35
	— Middleburgh .	51 30	3 37
	Goeree Island .	51 46	3 52
	Schowen Island light	51 39	3 40
	North Gatt . .	51 55	3 59
	Holland's Hook .	51 56	4 00
	The Hague . .	52 4	4 16
	Leyden . .	52 9	4 26
	Haerlem . .	52 22	4 36
	ROTTERDAM .	51 54	4 28
	AMSTERDAM .	52 22	4 51
	Alkmaer . .	52 39	4 38
	Texel, S. point .	53 2	4 33
Germany.	Harlingen, . .	53 10	5 20
	Gottingen, Obs. .	51 32	9 53
	EMBDEN . .	53 20	7 10
	BREMEN .	53 5	8 49

		Lat. D. M.	Long. D. M.
	Bremerlehe . .	53 32N.	8 32E.
	HAMBURGH . .	53 33	9 56
	Stade	53 36	9 28
	Glukstadt . . .	53 48	9 28
Denmark.	Cuxhaven . . .	53 52	8 46
	Nework . . .	53 55	8 32
	Elbe River, entrance .	54 00	8 20
	Tonningen . . .	54 19	9 5
	Holmen . . .	57 8	8 34
	Robsnout . . .	57 25	9 34
	SCAW light . .	57 43	10 37

XXIII. *Cattagat and Sound.*

		Lat. D. M.	Long. D. M.
	SCAW LIGHT . .	57 43N.	10 37E.
Jutland.	Fladstrand . .	57 26	10 32
	Sebye . . .	57 20	10 31
	Halls	57 00	10 19
	Grenaa . . .	56 26	10 53
	Aars	56 9	10 19
	Sleswick . . .	54 32	9 33
	The NAZE . .	58 1	7 14
	Christiansand . .	58 9	8 12
	Arendad . . .	58 26	8 57
Norway.	Frederickavern . .	58 59	10 12
	Ferder light . .	59 1	10 38
	CHRISTIANA . .	59 55	10 52
	Frederickstadt . .	59 12	11 2
	Stronstadt . . .	58 55	11 12
	Salo Beacon . .	58 21	11 14
	Paternosters . .	57 55	11 27
	Marstrand light . .	57 53	11 37
	GOTHENBURGH	57 42	11 57
	Winga Beacon . .	57 38	11 38
	Tislarne . . .	57 30	11 44
	Niddingen lights . .	57 18	11 55
	Warberg . . .	57 6	12 15
	Falkenburg . . .	56 55	12 30
	Halmstadt . . .	56 40	12 56
	Laholm . . .	56 32	13 00
Sweden.	Wadero I. S. end .	56 26	12 35
	Engelholm : . .	56 14	12 52
	Koll light . . .	56 18	12 28
	Helsinburg . . .	56 2	12 42
	Landskrone . .	55 52	12 50
	Malmo . . .	55 36	13 1
	Falsterbo light . .	55 22	12 49
	Kioge	55 28	12 12
	COPENHAGEN .	55 41	12 34
	ELSINEUR . .	56 2	12 37
Zeeland.	Cronenburg light .	56 3	12 37
	Nakke Head lights .	56 7	12 22
	Nykoping . . .	55 55	11 40
	Callunburg . . .	55 41	11 6
	Korsar lights . .	55 20	11 9
	Wordingburgh . .	55 1	12 00
	Huen I. Uraniberg .	55 55	12 43
	Amag I. Drago . .	55 35	12 38
	Haselo Island . .	56 12	11 44
	Anholt light . .	56 44	11 36
	Little Middle Ground .	56 57	11 59
	Lessou I. E. end . .	57 19	11 8

		Lat. D. M.	Long. D. M.
	Lessou I. W. end . .	57 15N	10 50E.
	Trindelen Rock . .	57 28	11 13

XXIV. *The Baltic.*

		Lat. D. M.	Long. D. M.
	Funen, Odensee . . .	55 25N.	10 24E.
Denmark Islands.	— Nyborg . . .	55 21	10 50
	Langeland Rudkoping .	54 56	10 48
	Arco Kiop . . .	54 54	10 28
	Alsen. Sonderborg .	54 56	9 52
	Laaland, Naskou .	54 51	11 15
	— Nysted . . .	54 42	11 48
	Falster Nykoping .	54 47	11 54
	— Stubbekioping .	54 54	12 8
	Moen, Stege . .	55 00	12 19
	Fermeren, Borge .	54 28	11 17
	Tralleborg . . .	55 22	13 11
	Cimbrishamn . .	55 35	14 18
	Ahus	55 56	14 14
	CARLSCROON . .	56 8	15 34
	Torum Point . .	56 5	15 55
	Calmar . . .	56 40	16 20
Sweden.	Westerwyck . .	57 44	16 41
	Soderkoping . .	58 30	16 20
	Nykoping . . .	58 46	17 3
	Trosa . . .	58 54	17 33
	Landford light . .	58 44	17 55
	STOCKHOLM . .	59 21	18 4
	Kiel	54 21	10 10
	LUBECK . . .	53 52	10 49
	Wismar . . .	53 52	11 40
	Rostock . . .	54 3	12 17
	Dars Head . . .	54 28	12 35
	Geblen light . .	54 28	13 12
German Coast.	Stralsund . . .	54 18	13 13
	Grieswald . . .	54 4	13 30
	Usedom . . .	53 53	14 5
	Wollin . . .	53 48	14 44
	Stettin . . .	53 23	14 32
	Cammin . . .	53 56	14 53
	Colberg . . .	54 7	15 43
	Rugenwale . . .	54 22	16 25
	Stolepemunde . .	54 30	16 50
	Heel light . . .	54 37	18 46
	DANTZIG . .	54 22	18 37
	Pillau	54 34	19 54
	KONIGSBERG . .	54 40	20 29
	Bruster Ort lights	54 52	19 54
	Memel . . .	55 42	21 3
	Libau	56 32	20 52
Russian Coast.	Windau . . .	57 25	21 24
	Lyserort . . .	57 35	21 34
	Domeness lights . .	57 46	22 28
	Runo Island light .	57 48	23 6
	RIGA . . .	56 56	23 57
	Pernau . . .	58 21	24 16
	Dago, Simperness .	59 6	22 32
	— Dagerort light .	58 56	22 9
	Osel, Palmer Ort .	58 39	22 25
	— Hund's Ort . .	58 32	21 50
	— Swasve Ort light .	57 56	22 3
	— Arensburgh . .	58 15	22 24
	Gatsko Sando . .	58 18	19 18
	Faro, N. E. end . .	57 56	19 26

		Lat. D. M.	Long. D. M.
Islands of the Baltic.	Gotland, N. E. end	57 51N.	19 2E.
	— WISBY	57 39	18 20
	— Hoburg	56 57	18 12
	Great Carlso	57 19	18 00
	Oland, N. end	57 22	17 7
	— Borgholms Slott	56 52	16 37
	— S. end light	56 12	16 26
	Eartholms	55 19	15 16
	Bornholm, N. W. end		
	— light	55 18	14 49
	— Hasle	55 10	14 47
	— S. E end	54 58	15 14
	— Svanike	55 8	15 16
	Rugen, N. end	54 40	13 30
	— BERGEN	54 25	13 32
	— S. E. end New Deep	54 16	13 52

XXV. *Gulfs of Finland and Bothnia.*

		Lat. D. M.	Long. D. M.
Russia.	Odensholm light	59 19N.	23 18E.
	Great Roge light	59 25	24 3
	Surep Head light	59 28	24 23
	Nargen I. N. point	59 36	24 34
	REVEL	59 26	24 48
	Kokskar light	59 40	25 6
	Chalk Ground	59 41	26 15
	Stone Skar	59 46	26 30
	Little Titters Island	59 47	27 3
	Great Titters Island	59 50	27 20
	Lavanscar, N. end	59 59	27 57
	Seascar light	59 59	28 28
	Narva	59 20	28 24
	Dolgenos	59 53	29 6
	Tolbecon light	60 00	29 39
	CRONSTADT	59 58	29 53
	PETERSBURG	59 56	30 19
	Styrs Udden	60 8	29 10
	Wiburg	60 39	28 54
	Fredericksham	60 30	27 25
	Aspo	60 14	27 22
	Hogland Island lights	60 3	27 7
	Orrengrund's Beacon	60 14	26 39
	Lovisa	60 25	26 28
	Borgo	60 21	25 50
	Helsinfors	60 10	25 7
	Hango Beacon	59 45	22 57

XXVI. *Gulf of Bothnia.*

		Lat. D. M.	Long. D. M.
Bothnia.	Uto light	59 47N.	21 25E.
	Abo	60 27	22 15
	Wasa	63 13	21 55
	TORNEA	65 51	24 9

XXVII. *From the Naze to Archangel.*

		Lat. D. M.	Long. D. M.
Norway.	The NAZE	58 1N.	7 14E.
	Lister Land	58 10	6 38
	Judder, or Walbert's Hd.	58 36	5 40
Norway.	Great Wylingsoe light house	59 4N.	5 26E.
	Stavanger	58 59	5 45
	Bommel Island, S. end	59 32	5 00
	BERGEN	60 24	5 12
	Askwold	61 22	5 12
	Ronde light	62 23	5 41
	Christian Sound	63 11	7 30
	Drontheim	63 26	10 22
Lapland.	Werro Island	67 42	11 25
	NORTH CAPE	71 10	26 00
	Wardhuus Island	70 22	31 6
	River Kola	69 15	33 24
White Sea.	Nagel Island	68 23	35 55
	Cape Sweetnose	67 58	37 30
	Cape Orlogenose	67 00	39 21
	Cross Island	66 19	38 49
	Onega	63 36	37 20
	Cape Donega	64 45	35 46
	ARCHANGEL	64 34	38 59
	Bluenose	65 21	38 10
	Cape Good Fortune	66 24	40 28
	Morshom Island	66 40	40 35
	Cape Candinose	68 23	41 28
	Welgate's Straits	70 50	62 2
	Nova Zembla	78 00	70 00

XXVIII. *From Ushant to Gibraltar.*

		Lat. D. M	Long. D. M
West Coast of France.	USHANT	48 29N.	5 3W
	BREST	48 23	4 29
	Saint Matthew's light	48 19	4 47
	Point Raz	48 1	4 47
	Saints Rocks	48 4	5 5
	Point L'Abbe	47 49	4 12
	Quimper	47 58	4 8
	Isles de Glenan	47 44	4 00
	Quimperlay	47 52	3 34
	L'ORIENT	47 45	3 21
	Port Louis	47 43	3 21
	Isle de Groas	47 38	3 28
	Quiberon, S. point	47 26	3 4
	Belle Isle, N. end	47 23	3 14
	— S. end	47 17	3 5
	Vannes	47 39	2 46
	Houat Isle	47 24	2 56
	Dumet Isle	47 22	2 36
	NANTES	47 13	1 33
	Croisic	47 18	2 31
	St. Gildas point	47 10	2 16
	Noirmoustier I. S. W.	47 00	2 15
	Dieu Isle	46 42	2 27
	St. Gillies	46 40	1 51
	Roche Bon[illegible]	46 15	2 24
	Ree Isle Light	46 15	1 34
	ROCHELLE	46 9	1 9
	ROCHEFORT	45 56	0 58
	Oleron Isle light	46 3	1 24
	Island Aix	46 1	1 10
	CORDOVAN light H.	45 35	1 10
	Medoc	45 6	0 45
	BORDEAUX	44 50	0 34
	Cape Feret	44 43	1 14
	BAYONNE	43 29	1 29

		Lat. D.	Lat. M.	Long. D.	Long. M.
	St. John de Luz	43	23N.	1	38W
	St. Sebastian	43	21	1	57
	Cape Machicao	43	28	2	40
	BILBOA	43	15	2	44
	SAINT ANDERO	43	28	3	40
North Coast of Spain.	Saint Vincent	43	30	4	16
	Villa Viciosa	43	28	5	18
	Cape Penas	43	42	5	46
	Cape Burola	43	42	7	17
	Cape Vanas	43	47	7	35
	Cape Ortegal	43	47	7	48
	Cape Prior	43	34	8	14
	FERROL	43	30	8	6
	CORUNNA	43	23	8	20
	Cape Belem	43	10	9	10
	Cape Turiana	43	3	9	17
	Cape Finistere	42	54	9	17
	Vigo Bay	42	14	8	37
	Cape Fasalis	41	59	8	45
	OPORTO	41	11	8	38
	Averios	40	39	8	41
Portugal.	Coimbre	40	14	8	24
	Cape Mondego	40	12	8	54
	Cape Fiseraon	39	24	9	18
	The Burlings	39	25	9	31
	The Rock of Lisbon	38	46	9	29
	LISBON	38	42	9	9
	Cape Epichel	38	25	9	14
	St. Ubes	38	32	8	50
	Sines	37	50	8	54
South Coast of Spain.	Cape St. Vincent	37	3	9	2
	Lagos	37	8	8	39
	Cape Carbonera	37	7	8	19
	Cape St. Mary	36	57	7	52
	Point Arenilla	37	8	6	50
	St. Lucar	36	46	6	20
	SEVILLE	36	59	5	58
	CADIZ	36	32	6	18
	Cape Trafalgar	36	10	6	00
	Tarifa Island	36	1	5	35
	P. Carnero	36	5	5	23
	Algesiras	36	7	5	24
	GIBRALTAR	36	6	5	20

XXIX. *The North Coast of the Mediterranean Sea, from Gibraltar to Constantinople.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	GIBRALTAR	36	6N.	5	20W
	MALAGA	36	43	4	24
	Modril	36	45	3	33
	Almeria	36	51	2	31
South Coast of Spain.	Cape de Gatt	36	44	2	13
	Point Calla	36	47	2	00
	CARTHAGENA	37	36	1	1
	Cape Pallos	37	37	0	41
	ALICANT	38	18	0	29
	Cape St. Martin	38	47	0	10E.
	VALENCIA	39	26	0	20W
	Cape Oropeso	40	6	0	8E.
	River Ebro	40	42	0	27
	Terragona	41	9	1	19
	BARCELONA	41	22	2	12
	Cape St. Sebastian	41	53	3	9

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Bay of Roses	42	15N.	3	7E.
	Cape de Greux	42	20	3	17
	Perpignan	42	42	2	54
	Agde	43	19	3	28
	Fort Brecon	43	15	3	29
	Cette light	43	24	3	42
South of France.	Narbonne	43	11	3	00
	Montpeller	43	37	3	52
	MARSEILLES	43	18	5	22
	Ciotta	43	10	5	36
	TOULON	43	7	5	55
	Cape Taillar	43	7	6	44
	St. Tropez	43	16	6	40
	Frejus	43	26	6	44
	Cape Roux	43	22	7	00
	Antibes	43	35	7	7
	St. Marguerite Island	43	31	7	3
	Cape de Oropes	43	28	7	10
	Nice	43	42	7	17
	Villa Franca	43	40	7	20
	Cape Melle	43	56	8	8
	Savona	44	17	8	30
	GENOA	44	25	8	56
	Rapallo	44	23	9	16
	Point Venere	44	3	9	45
	LEGHORN	43	33	10	22
	Maloria	43	33	10	17
	Cape M. Nero	43	25	10	20
West Coast of Italy.	Vada	43	20	10	41
	Piombino	42	56	10	35
	Point Hercole	42	23	11	10
	Civita Vecchia	42	5	11	46
	ROME	41	54	12	28
	Cape Dazia	41	26	12	40
	Cercello Point	41	9	13	00
	Gaeta	41	15	13	38
	NAPLES	40	51	14	11
	Salerno	40	42	14	46
	Cape Licosa	40	18	14	57
	Policastro	40	7	15	43
	St. Eufemia	39	00	16	42
South of Italy.	Cape Batican	38	47	16	25
	Cape Grose	38	20	16	10
	Cape Larme	37	56	16	15
	S. Point of Italy	37	53		
	Cape Spartavento	37	57	16	22
	Cape Stillo	38	26	16	55
	Catanzaro	39	1	16	55
	Cape Rizuta	38	54	17	31
	Cape Callone light	39	4	17	36
	Tarento	40	28	17	35
	Galipoli	40	00	18	20
	Cape St. Mary, the entrance to the Gulf of Venice	39	50	18	50
	Otranto	40	19	18	55
	Brindisi	40	38	18	12
	Bari	41	9	17	00
	Manfredonia	41	40	16	8
	Ortona	42	20	14	30
	Ancona	43	38	13	30
	Ramino	44	4	12	33
	VENICE	45	26	12	21
	TRIESTE	45	46	13	47
	Rovigno	45	9	13	48
	St. Maria	45	30	14	15

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Segna	45	14N.	14	58E.
	Pescera	44	45	15	40
	Zara	44	17	15	35
Gulf of Venice.	Cape Sesto	43	42	16	10
	Rosaro	43	2	17	10
	Ragusa	42	40	18	11
	Cataro	42	23	19	29
	Durazo	41	30	20	00
	Cape Patti	41	20	19	46
	La Valona	40	45	20	16
	Cape Linguette	40	32	19	55
	Butrinto	39	47	20	33
	Cape St. Nicholas	39	24	20	36
	Lepanto	38	16	22	4
	Coron	36	46	21	50
	Cape Matapan	36	23	22	30
	Cape St. Angelo	36	27	23	12
	Corinth	37	53	23	2
	ATHENS	37	58	23	46
	Negropont	38	27	23	44
	Cape Doro	38	9	24	40
Turkey in Europe.	Cape St. George	39	25	23	17
	SALONICA, or Salonique	40	38	22	56
	Cape Ballouri	40	00	23	40
	Mount Athos	40	7	24	15
	Contessa	40	39	23	58
	Lagos	40	40	24	50
	Cape Macri	40	30	25	38
	The Dardanelles	40	3	26	6
	Adrianople	41	3	27	6
	Galipoli	40	26	26	37
	CONSTANTINOPLE	41	1	28	55

XXX. *The Black Sea and Sea of Azof.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Ismayl	45	21N.	28	50E.
	Akerman	46	11	30	16
Black Sea.	Odessa	46	28	30	37
	Kherson	46	38	32	56
	Koslof	45	15	33	25
	Sevastopol	44	40	33	36
	Yenicale	45	22	36	27
	Fanagoria	45	12	36	30
	Teganroy	47	12	38	39
	Trebizonde	41	2	39	37
	Cape Yassoun	41	10	37	48
	Sinope	42	3	35	9

XXXI. *The South Coast of the Mediterranean Sea.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Cape Spartel	35	49N.	5	54W.
	TANGIER	35	40	5	49
	Ceuta	35	54	5	16
Coast of Barbary.	Tetuan	35	19	5	27
	Cape Negril	35	14	4	24
	Cape Baalal	35	10	3	44
	Cape Three Forcas	35	28	2	57
	Zaffarma	34	57	2	8
	Cape Fegalle	35	47	1	9
	Cape Falcon	35	5[illegible]	0	48
	Cape Ferrat	36	2N.	0	10W.
	Cape Tennis	36	38	1	16E.
	ALGIERS	36	49	2	13
	Cape Matifor	36	55	2	43
	Cape Beringu	36	53	3	30
	Cape Tenels	36	59	4	10
	Cape Bugaroni	36	50	5	47
	Cape Ferro	36	52	6	54
	Bona	36	32	7	36
Coast of Barbary.	Tabarca	36	48	8	58
	Cape Serra	37	10	9	24
	Cape Blanco	37	20	9	53
	TUNIS	36	32	10	34
	Cape Bon	37	5	11	8
	Susa	35	45	10	50
	Cape Paul	35	14	11	15
	Cape de Zoara	33	53	11	10
	Tehy	33	12	11	24
	TRIPOLI	32	54	13	11
	Lebida	32	8	14	55
	Cape Mensurato	32	12	16	15
Lybia.	Cape Lorat	30	50	17	22
	Cape Linconta	30	29	19	20
	Cape Serabion	31	21	20	16
	Zoara	30	44	20	45
	Bengaza	32	16	20	20
	Cape Docra	32	55	21	26
	DERNE	32	48	22	11
	Cape Razatin	32	30	23	5
	Cape Luco	31	50	25	00
	Cape Soliman	31	44	25	18
Egypt.	Point Ramadan	31	32	26	00
	Cape Lagosego	31	23	27	20
	Cape Capopera	31	13	28	44
	Cape Rose	31	8	29	30
	ALEXANDRIA	31	13	30	16
	Aboukir	31	18	30	38
	Rosetta	31	24	30	58
	Cape Bourlos	31	33	31	30
	Demietta	31	24	32	7
	Cape Callo	31	20	33	30
	El Arish	31	13	33	50
	Jaffa	32	5	35	3
	M. Carmel	32	50	35	16
	Acre	33	00	35	26
Syria.	Cape Blanco	33	10	35	19
	Cape Serpente	33	28	35	35
	Cape Vardo	34	22	35	50
	Tripoly	34	46	36	7
	Tortosa	35	22	36	8
	Cape Zaret	36	14	35	53
	ALEXANDRETTA, or Scanderoon	36	35	36	20
	Yasso	36	58	36	15
	ALEPPO	36	11	37	10
	Cape Urco	36	40	34	12
	Point Calvero	36	34	33	25
	Cape Draumonte	36	30	32	20
	Satalia	37	3	30	55
Turkey.	Cape Chelidoni	36	18	30	40
	Rosso Island	36	8	29	59
	Cape Seven capes	36	26	29	00
	Macri	36	40	29	30
	Cape Baibe	36	38	27	45
	Cape Crio	36	45	27	15
	Cape St. Mary	37	38	27	7

		Lat. D.	Lat. M.	Long. D.	Long. M.
Turkey in Asia.	Cape Black	38	46N	26	25E.
	SMYRNA	38	28	27	20
	Adramitta	39	37	27	5
	Cape Baba	39	35	26	10
	Cape Janesari	40	3	26	24
	Mondania	40	26	28	50
	Scutari	40	57	29	4

XXXII. *Islands within the Straits.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Alboran	36	1N.	3	00W
	Fromentera, W. point	38	39	0	57E.
	— E. ditto	38	43	1	24
	Ivica, S. ditto	38	50	0	55
	—N. E. ditto	39	15	1	25
	Salina	38	49	0	50
	Cabrera S. point	39	12	2	37
Majorca.	MAJORCA, S. point	39	20	2	42
	— N. ditto	40	7	3	00
	— W. ditto	39	45	2	7
	— E. ditto	39	42	3	17
	— MAJORCA TOWN	39	34	2	39
	Dragon Island	39	49	1	59
	Colebres	39	52	0	30
	Minorca, S. point	39	43	3	42
	— PORT MAHON	39	52	4	22
	— N. point	40	18	3	35
Corsica.	Cape Corse	43	2	9	19
	Saint Florenzo	42	35	9	16
	Calvi	42	30	8	40
	Ajacio	41	52	8	44
	South point	41	21	9	21
	Cape Signo	42	14	9	37
	BASTIA	42	27	9	32
Sardinia.	N. P. Lagosardo	41	14	9	2
	Cape Asinara	40	53	8	6
	Cape Caccia	40	31	8	7
	Cape Otano	39	9	8	14
	Cape Malfetena	38	50	8	54
	CAGLIARI	39	15	9	30
	Cape Carbonera	38	57	9	48
	Cape Frances	39	39	9	50
	Olaster	40	8	9	34
	Cape Cavallo	40	48	9	47
	Asinara Isl. N. point	41	7	8	14
	Antioch Island	38	55	8	15
	Toro	38	47	8	18
	Galita Island	37	38	9	3
	Gorgona	43	25	9	51
	Cabrera	43	8	9	50
	Elba	42	50	10	12
	Planera	42	43	10	7
	Formigues	42	33	10	5
	Monte Christo	42	17	10	26
	Gilio	42	22	11	00
	Ganuto	42	16	11	10
	Palmaria	40	43	13	00
	Posea	40	42	13	6
	Ischia, S. point	40	38	13	56

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Capra	40	31N	14	18E.
Sicily.	MESSINA	38	14	15	49
	Cape Orlando	38	20	14	40
	Cape Cefala	38	15	14	5
	Cape Cafrana	38	18	13	36
	PALERMO	38	7	13	20
	Cape Alos	38	18	13	23
	Cape St. Visto	38	17	12	50
	Tripano	38	9	12	36
	Cape Ruxo	37	17	13	20
	Cape Alicate	37	3	13	50
	Cape Secha	36	49	14	26
	Cape Passari	36	41	15	38
	Saragossa	37	5	15	30
	Cape Carmale	37	24	15	39
	Cape Moline	37	37	15	43
	Stromboli	38	56	15	44
	Lipari, S. point	38	37	15	7
	Salina	38	44	14	55
	Volcano	38	32	15	7
	Felicudi	38	35	14	27
	Alicudi	38	36	14	12
	Ustica	38	51	13	20
	Levaci	38	5	12	25
	Maretimo	38	1	12	5
	Favognana	37	56	12	23
	Quill Rocks	37	35	11	15
	Pantellaria	36	45	12	31
	Linosa	35	52	12	55
	La Pidossa	35	31	12	47
	Lampion	35	30	12	30
Malta.	Gozo, N. point	36	3	14	5
	C. Comoneto	35	54	14	11
	La Valette	35	54	14	29
	Cape Nicholas	35	47	14	39
Gulf of Venice.	Fano, entrance to the gulf of Venice	40	5	19	32
	Pelagosa	42	23	16	20
	Plana	42	20	16	3
	Tremiti	42	19	15	40
	Lissa, S. point	42	57	16	15
	Pomo	43	13	15	46
	Longa, S. E. point	44	1	15	48
	Corfu, S. E. point	39	47	20	1
	Paxu, S. point	39	24	20	22
	St. Maura, W. point	38	54	20	41
	Cefalonia. S. point	38	7	20	53
	— Cape Viscardo	38	30	20	47
	Zante, S. point	37	50	20	49
Archipelago.	Cerigo, S. Point	36	20	23	1
	Cerrigotto	35	54	23	24
	Milo, Town	36	41	24	50
	Scio, Town	38	30	26	3
	Mytelene, Town	39	12	26	27
	Tenedos	39	50	26	6
	Lemnos	39	54	25	28
Candia.	C. Crio	35	12	23	39
	Cape Spada	35	47	23	57
	Suda	35	30	24	24
	Cape Sassosso	35	35	25	7
	CANDIA	35	19	25	18

		Lat. D.	Lat. M.	Long. D.	Long. M.
Candia.	Cape Sidera	35	22N.	26	28E.
	Cape Salamone	35	00	26	20
	Goza	34	50	24	1
	Goxa, S. point	35	24	27	2
	Scapanto	35	37	27	7
	Rhodes, Town	36	27	28	30
	Rhodes, CapeSt.Gioane	35	57	28	21
Cyprus.	Cape Andrew	35	41	34	32
	Charma	35	19	32	47
	Cape Salizani	35	3	31	41
	Cape Gatto	34	34	33	8
	Cape Grego	35	7	34	5

XXXIII. *The Coast of Africa from Cape Spartel to Cape Verd.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Cape Spartel	35	49N.	5	54W
Fez.	Larash	35	11	6	12
	New Sallee	34	5	6	43
	Mazagan	33	18	8	25
	Cape Blanco	33	8	8	40
	Cape Cantin	32	35	9	5
	Saffia Bay	32	20	8	46
Morocco.	MOGADORE Island	31	25	9	31
	Cape Geer	30	38	9	52
	Cleveland's Shoal	30	45	10	21
	Santa Cruz	30	30	9	38
	Cape Nun	28	37	11	15
	Entrance of R. Nun	28	17	11	31
	Cape Blanca	27	54	12	42
	Cape Bajador	26	12	14	27
	Cape Das Barbas	22	15	16	40
	Cape Blanco	20	55	17	10
	Cape St. Ann	20	33	16	38
	Cape Myric	19	10	16	20
Senegal.	Portendic	18	7	16	3
	SENEGAL, P. Breberie	15	53	16	31
	CAPE VERD	14	47	17	33

XXXIV. *The Western Islands.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Corvo	39	44N	31	7W
	Flores	39	26	31	7
	Fayal, S. E. point	38	30	28	42
	Pico, Point de Espertal	38	26	28	35
	— Summit of Peak	38	27	28	28
	St. George, S. E. point	38	31	27	50
Pico.	Graciosa, Villa da Praya	39	2	27	40
	Terceira, Angra	38	39	27	12
	St. Michael, P. Delegada	37	45	25	39
	— Point Ferraria	37	54	25	58
	— N. E. Point	37	49	25	15
	Formigas or Ants	37	17	24	54
	St. Mary, Town	36	59	25	10
	— West Point	36	59	25	14

XXXV. *Madeira Islands.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Porto Santo, Town	33	4N	16	14W
	Madeira, Lorenzo pt.	32	43	16	36
	Madeira, Tristam point	32	54N.	17	14W
Madeira.	— FUNCHAL	32	38	16	54
	S. Desertos, S. point	32	22	16	25
	Isl. Salvages, middle	30	13	15	42
	Piton	30	5	15	54

XXXVI. *Canary Islands.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Palma, Town	28	39N.	17	50W
	— N. point	28	50	18	00
	— S. point	28	31	17	56
	Ferro, Valverde	27	47	17	56
	Gomero, St. Sebastian	28	6	17	8
	Teneriffe, Hidalgo point	28	40	16	21
Teneriffe.	— Orotava	28	24	16	36
	— Tena Point	28	17	17	1
	— Peak	28	16	16	46
	— Port Christianos	27	57	16	52
	— SANTA CRUZ	28	27	16	16
	Canary, N. E. point	28	13	15	38
	— Palmas	28	8	15	43
	— S. W. point	27	45	16	3
	Fuerteventura				
	— Point Gorda	28	46	13	52
	— S. W. point	28	4	14	31
	Lanzarote, S. point	28	51	13	35
	— Puerto de Naos	28	57	13	22
	Punta del Farion	29	14	13	12
	Graciosa	29	14	13	14
	St. Claire	29	17	13	13
	Alegranza	29	20	13	10

XXXVII. *Cape Verd Islands.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
St. Anthony.	St. Anthony, N. W. P.	17	12N.	25	19W
	— N. E. point	17	8	25	8
	— SANTA CRUZ	17	2	25	15
	St. Vincent	16	59	25	6
	St. Lucia	16	46	24	55
	St. Nicholas, N. point	16	46	24	37
	— East point	16	28	24	12
	Salt Island	16	45	22	56
	Bonavista	16	4	22	45
	Leton Rock	15	49	23	14
	Isle of May	15	6	23	5
	St. Jago				
	—PORTO PRAYA	14	54	23	30
	— N. W. point	15	26	23	48
	Fogo, N. point	14	57	24	22
	— Middle	14	52	24	23
	Brava, S. point	14	50	24	43

XXXVIII. *From Cape Verd to the Cape of Good Hope.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	CAPE VERD	14	48N.	17	33W
Senagambia.	Goree Isle	14	40	17	25
	Cape Naze	14	29	17	12
	Cape St. Mary, ent. to the River Gambia	13	19	16	40
	Cape Roxo	12	12	16	48
	Cape Verga	10	5	13	56

		Lat. D. M.	Long. D. M.
	Delos Isles . .	9 22N.	13 26W
	CAPE SIERRA LEON	8 29	13 3
	St. Ann's Shoal, W. P.	7 5	13 28
	Cape Ann . . .	7 6	12 21
	Cape Mount . .	6 46	11 10
	Cape Mesurada . .	6 21	10 40
	Sestos River . .	5 34	9 13
	Cape Palmas . .	4 30	7 41
	St. Andrew's River .	5 00	6 10
	Cape Lahon . .	5 15	5 17
	Cape Appolonia . .	4 59	3 10
	AXIM . . .	4 53	2 55
	Cape Three Points .	4 36	2 44
	Dix Cove Fort . .	4 44	2 38
Guinea.	Sakondee . . .	4 54	2 20
	Elmina . . .	5 2	2 00
	Cape Corse Castle .	5 7	1 52
	Anamoboe Fort . .	5 9	1 41
	Acra . . .	5 30	0 12
	Cape St. Paul . .	5 52	0 48E.
	Whidah . . .	6 24	2 12
	Formosa River . .	5 33	4 35
	Cape Formosa . .	4 18	5 10
	New Callabar River .	4 20	6 50
	Cameroon's River .	3 33	9 5
	Cape St. John . .	1 15	8 36
	Gabon River . .	0 28	8 45
Congo.	C. de Lopas Gonsalvez	0 56S.	8 43
	Sesto River . .	2 32	9 50
	Congo River . .	6 10	12 25
	Ambris Bay . .	7 56	13 15
	Dande Point . .	8 38	13 47
	Cape Ledo . .	9 48	13 28
	Novo Redondo . .	11 20	13 48
	St. Philip de Benguela	12 39	13 29
	Cape Negro (appears like black hommocks)	16 00	11 54
	Tiger's Island, N. P.	16 30	12 1
	Cape Frio . . .	18 40	12 42
	Walwich Bay . .	22 55	14 40
	Illhea Point . .	23 38	14 40
	Angra Pequena . .	26 37	15 16
	Elizabeth Bay . .	27 00	15 37
	St. Helen's Bay, (Cape St. Martin's) . .	32 42	17 40
	Saldanah Bay . .	33 7	18 7
	Dassen Island . .	33 25	18 7
Caffraria.	Table Bay, Robin Isl.	33 49	18 25
	Cape of Good Hope Town . . .	33 58	18 28
	CAPE of GOOD HOPE	34 24	18 28

XXXIX. *Islands between Cape Verd, the Cape of Good Hope, and Cape Horn.*

		Lat. D. M.	Long. D. M.
	St. Paul's . . .	0 55N.	29 13W
	Ferdinand Noronha .	3 55S.	32 35
	The Roccas (dangerous)	3 52	33 26
	Fernand de Po, N. P.	3 25N.	7 36E.
	Prince's Island . .	1 33	7 27
	St. Thomas, (Man of War's Bay) . .	0 27	6 45
	St.Th's. M.of W.B S.P.	0 5N.	6 35E.
	Annabona . .	1 32S.	5 45
	Trinidad . . .	20 28	29 5W
	Martin Vas, (largest)	20 31	28 38
	ASCENSION . .	7 56	14 16
	ST. HELENA, James Town . . .	15 55	5 36
	Saxemburgh* . .	30 22	24 00
	Tristran d'Acunha, N. P.	37 7	11 48
	Inaccessible Island .	37 20	12 25
	Nightengale Island .	37 27	12 16
	Hibernia Rocks (doubt.)	37 31	4 42
	Diego Alvarez (doubt.)	39 20	11 2
	Gough's Island . .	40 19	9 50
	I. Raza, N. W. point .	50 59	61 28
	Salvage's Isl's. N. point	50 59	61 18
	The Sisters . .	51 7	60 26
	Port Egmont . .	51 22	60 1
	Island Concha . .	51 15	59 00
	Cape Leal . . .	51 21	58 57
	Point de la Barra, N.E. Point . . .	51 28	57 41
Falkland Islands.	Cape Corientes . .	51 24	57 52
	Port Soledad . .	51 33	58 00
	Cape St. Philip, E. P.	51 43	57 40
	Beauchenes I. S. point	52 45	58 59
	Porpus point . .	52 28	59 28
	Cape Meredith . .	52 4	60 40
	Cape Orford . .	51 56	61 00
	Cape Percival . .	51 47	61 11
	Aurora Isles, . .		
	— Northernmost .	52 43	48 10
	— Southernmost .	53 25	47 59
	Eagle Reef . .	51 51	64 32
	Alexander I. Island .	69 30	75 00
	Peter's I. . . .	69 30	90 00
	Island Georgia, . .		
	— Cape Buller . .	53 58	37 40
Georgia.	— Cape Disappointment	54 58	36 15
	— Willie's Isle . .	54 00	38 26
	— Clerk's Islands .	55 5	34 42
	Sandwich Land, (Cape Montague) . .	58 33	26 46
Sandw.	— Candlemas Isles .	57 10	27 13
	— Southern Thule .	59 34	27 45
	Isle of Circumcision .	54 16	6 14E.

XL. *From the Cape of Good Hope to Canton, with the adjacent Islands and Shoals.*

		Lat. D. M.	Long. D. M.
	CAPE of GOOD HOPE	34 24S.	18 28E.
	Cape False . .	34 25	18 41
S. Coast of Africa.	CAPE AQUILHAS, or LAGULLUS . .	34 55	20 18
	Cape Infanta, S. ent. to St. Sebastian's Bay .	34 35	20 54
	Cape Vaches . .	34 24	22 5

* The existence of this Island is considered doubtful. Though the appearance of land is said to have been seen by several vessels in various situations, from 30° 8' S. to 30° 45' S. and from 20° 50' E. to 28° 20' E. The Island St. Matthew does not exist, being the same as Annabona.

	Lat. D.	Lat. M.	Long. D.	Long. M.
South Coast of Africa.				
Cape St. Blas, S. Mossel Bay	34	10S.	22	18E.
Cape Delgado, S. ent. Plettemberg Bay	34	6	23	48
Cape Mountains	34	14	25	00
Algoa Bay, Cape Recife	34	2	25	42
Chaos, or Bird Islands	33	48	26	22
Doddington Rock	33	53	26	20
Cape Padron	33	40	26	34
Rio de Infanta, ent.	33	25	27	37
Keiskammer River, ent.	33	12	28	7
First point of Natal	32	22	29	25
Middle pt. of Natal	31	8	30	45
Third pt. of Natal	30	15	31	22
Port Natal	29	55	31	28
Point St. Lucia	28	36	32	48
Smoky Point, C. Fumos	27	13	33	15
East Coast of Africa.				
Delagoa Bay,				
— Cape St. Mary, N. E. P. I. St. Mary	25	58	33	15
— English River, anchorage	25	58	32	41
Cape Corientes	24	2	35	51
Inhamban Bay, Sand Point on E. side Bay	23	47	35	52
Cape St. Sebastian, about	22	00	36	00
Bazaruta Isl. N. end, (about)	21	12	36	00
Sofala Bay,				
— Shoal off Sofala	20	47	35	38
— Chulawan or Holy I.	20	36	35	4
— Sofala, fort	20	15	34	45
Quilimane River, ent.	18	10	37	30
Rocky Bank	17	39	38	27
Fogo, or Fire Island, off Quizungo	17	12	38	52
Razor Island	17	5	39	12
Angoxa Islands,				
— Western, Caldeira	16	40	39	40
— Eastern, Mafamale	16	21	40	25
MOZAMBIQUE	15	1	40	47
Querimba Island, about	12	20	40	58
Cape Delgado	10	6	40	50
Quiloa	8	41	39	47
Zanzibar Island, S. P.	6	28	39	46
— N. P.	5	40	39	46
Pemba or Keddree, S. P.	5	30	40	19
— N. P.	4	50	40	26
Mombas Harbour, ent.	4	4	40	2
Chenee River	3	37	40	7
Quilise River	3	25	40	19
Leopard's Reef	3	16	41	2
Formosa Bay, S. point	3	00	41	2
— N. point	2	39	41	21
Patta	2	10	41	18
Daedalus Shoal	0	23	43	4
Juba	0	12	43	2
Brava	1	8N.	44	10
Magadoxa	2	5	45	49
Cape Bassas	4	50	48	49
Moro Cobir Point	8	30	50	45
Cape Delgado, north	10	00	51	17
Cape Orfui	10	22	51	39
Cape Guardafui	11	50	51	32
Socotra Island, E. P.	12	30	54	52
— W. P.	12	37	53	32

	Lat. D.	Lat. M.	Long. D.	Long. M.
Socotra Island, S. P.	12	13N		
— Tamarida Bay	12	40	54	23E.
Abdul-Curia Island	12	5	52	32
Cape Felix	12	00	50	50
Cape St. Peter	11	37	50	3
Matte Island	11	21	48	58
Ais, or Burnt Island	11	14	47	28
Berbera	10	22	45	10
Zeyla	11	17	43	5
Red Sea.				
Babelmandel or Perim Island	12	38	43	29
Babelmandel Cape	12	40	43	32
Panther's Shoal	12	56	43	8
Ras Rattah	14	56	40	55
Dhalac Island	15	32	40	15
Massowah Bay	15	34	39	37
Port Mornington, ent.	18	16	38	32
Suakin	19	5	37	33
Mirza Sheik Baroud	19	35	37	24
Salaka	20	28	37	27
Cape Calmar	21	28	37	25
St. John's Island	23	38	36	10
Ras-el-ans, (Cape Nose)	23	56	35	48
Reef of Breakers	24	4	36	16
Three Islands	24	25	35	26
Reef of Breakers	24	54	35	49
Dedalus Shoal	24	58	35	56
Gebel Siberget	25	2	34	54
Centurion Shoal	25	20	35	48
Kosine	26	8	34	15
The Brothers	26	19	34	47
SUEZ	30	00	32	28
Cape Jehan	28	33	33	11
Tor Harbour	28	19	33	28
Ras Mahomed	27	43	34	15
Shaduan I. S. E. P.	27	26	33	54
Bareedy Harbour	24	17	37	45
Yambo	24	10	38	21
Juddah	21	29	39	15
Camfidia	19	7	40	50
Marabia Reefs W. P.	19	11	40	5
Doorhal I.	16	15	42	8
Loheia	15	44	42	44
Gebel Tor	15	32	42	00
Cape Israel	15	15	42	41
Gebel Zabayr	15	3	42	18
Hodeida	14	48	42	57
Shoal off Ras Magamel	14	35	42	56
Gebel Zeghir	14	2	42	52
Great Arroe	13	41	42	52
MOCHA	13	20	43	20
Arabia.				
Cape St. Anthony	12	39	44	14
Cape Aden	12	44	45	14
Cape Hargiah	13	30	47	2
Macula Bay	13	57	47	58
Cape Bogatshua	14	6	49	24
Kisseen Point	15	19	51	20
Cape Fartash	15	34	51	56
Dofar	17	3	54	10
Cape Morebat	17	00	54	32
Cape Monteval, N.E.P.	17	26	55	20
Curia Muria, I. Western	17	33	55	40
Cape Chanseley	18	2	56	30
Cape Isolette	18	58	57	48

Region	Place	Lat. D.	Lat. M.	Long. D	Long. M.
Red Sea.	Mazeira Islands, S.W.P.	20	00N.	58	19E.
	— N. E. P.	20	35	58	56
	Rasalhad, (Cape Rasalgat)	22	22	59	58
	Cape Kuriat	23	20	58	57
	Muscat	23	38	58	41
	Burka	23	41	57	56
	Point Deba	25	34	56	20
	——				
The Persian Gulf.	Cape Mussendorn	26	21	56	38
	Azab, or Gap Island	26	22	56	42
	Great Quoin Island	26	30	56	44
	Cape Jedee	26	8	56	12
	Rumps	25	54	56	3
	Rasulkhima	25	47	56	00
	Umrah, or Red Island	25	43	55	49
	Sharga	25	22	55	32
	Boothabeen	24	26	53	40
	Zara Island	25	10	53	46
	Dauss Island	25	10	52	45
	Jarnain Island	25	8	52	55
	Arzenie Island	24	56	52	33
	Dalmy Island	24	36	52	24
	Seer Beniyass I.	24	34	52	40
	Danie Island	25	1	52	20
	Sherarow Island	25	13	52	18
	Hawlool Island, (probably I. May)	25	41	52	23
	Ras Reccan	26	11	51	16
	Koor Hussan	26	2	51	11
	Katif Bay, N. P.	26	36	50	12
	Three low sandy isls.	27	42	49	30
	Sandy Island	27	52	49	25
	Rasulzoor	28	53	48	16
	Rasulurhud, (S. E. part of Graen Haven)	29	20	47	57
	Mulmaradam Island	28	48	48	38
	Graen	29	24	47	48
	Pherleeche Island	29	30	48	25
	Basra river bar	29	57	48	42
	BASRA or BUSSORAH	30	29	47	40
	Delam	29	55	50	18
	Cape Bang	29	46	50	27
	Karak Island	29	16	50	27
	Busheer	29	00	50	56
	Halilah Hills, N. P.	29	19	51	26
	Asses Ears	28	29	51	20
	Zezarine	28	2	49	54
	Keyn	27	49	50	4
	Cape Berdistan	27	58	51	26
	Konklun	27	49	52	6
	Cape Nabon	27	24	52	52
	Cherak Hill	26	56	54	17
	Busheab	26	48	53	25
	Arad Island	26	15	50	40
	Durable Shoal	26	55	50	26
	Crescent Shoal	26	44	51	43
	— ditto Favourite soundings	26	50	51	10
	Hinderabui Island	26	39	53	42
	Kyen or Kaez Island	26	29	54	8
	Polior or Belior Island	26	18	54	40
	Great Tumb I.	26	17	55	24
	Little Tumb I.	26	14	55	13
	Nobfleur I.	26	6	54	34
	Bormesa Island	25	51	55	9

Region	Place	Lat. D.	Lat. M.	Long. D.	Long. M.
The Persian Gulf.	Surde Island	25	50N.	54	39E.
	Cape Dsjera	26	36	54	42
	Cape Bostana	26	30	54	52
	Linga	26	33	55	1
	Kishm Island,				
	— S. W. Point	26	32	55	22
	— Point Bassadore, or N. W. P.	26	38	55	22
	— Luft	26	55	55	55
	— N. Point	27	2	56	20
	— Kishm Town	26	57	56	24
	Angaum I. mid.	26	39	55	57
	Lanek I. (conical hill)	26	52	56	28
	Ormus I. N. end, fort	27	7	56	37
	Gambroon	27	13	56	22
	Ras Koli, or Cape Hill	26	20	57	30
	Kohumbarek, or Bombarack Rock	25	52	57	46
	Cape Kohumbarek	25	49	57	46
	Kohumbarek Shoal	25	43	57	56
	——				
Persia.	Cape Jask	25	38	58	10
	Churbar	25	16	61	20
	Cape Gwadur or Guadel	25	4	63	12
	Cape Arubah	25	7	65	24
	Cape Monoze or Mowaree	24	51	66	50
	Korauchee or Crotchey	24	46	67	7
	River Scind, ent. grand branch	24	8	67	20
	Tattah	24	44	68	17
	Bate Castle	22	28	69	20
	Point Gigat	22	20	69	16
	Diu Head	20	42	71	6
	Jaffrabad	20	55	71	36
	Searbett Island	20	55	71	43
	Goapnat Point	21	12	72	18
	Cambay	22	24	72	39
	Swallow Point (Vaux Tomb)	21	4	72	51
	Surat Castle	21	11	73	5
	Demaun	20	22	73	9
	Highland of St. John	20	2	73	6
	Terrapore Point	19	50	72	49
	Basseen River	19	18	73	12
	Bombay, (flagstaff)	18	56	72	58
	Bombay light house	18	54	72	56
	Henery and Kenery Islands	18	42	72	57
	Coullaba Island	18	37	72	59
	Chaoul	18	32	73	1
	Radjapour harbour	18	16	73	2
	Bancoot River	17	57	73	9
	Sevendroog	17	47	73	13
	Dabul	17	46	73	15
	Argenwell Fort	17	34	73	15
	Boria Point	17	25	73	16
	Zughur Point	17	16	73	17
	Rettna-Geriah	17	2	73	22
	Radjapour Fort	16	47	73	25
	Geriah point & flagstaff	16	31	73	25
	Angrias Bank, N. P.	16	38	72	8
	— S. P.	16	18	72	8
	Dewghur harbour	16	23	73	32
	Atchera River	16	11	73	35
	Melundy (fortified Isl.)	16	3	73	36

		Lat. D. M.	Long. D. M.
Malabar.	Newtee Point . .	15 56N.	73 39E.
	Vingorla Rocks, or Burnt Islands . .	15 53	73 34
	Raree Point . .	15 44	73 44
	Chiracole Fort . .	15 41	73 47
	Chapra Fort . .	15 36	73 48
	Algoada Pt. N. ent. Goa Bay . . .	15 29	73 53
	GOA	15 28	73 58
	St. George's I. (western)	15 22	73 53
	Cape Ramas . .	15 5	74 6
	Oyster Rocks, outermost	14 48	74 14
	Carwar Head . .	14 47	74 16
	Anjedwa (island) .	14 44	74 16
	Merjee River . .	14 30	74 31
	Fortified Island . .	14 19	74 37
	Onore . . .	14 18	74 39
	Pigeon Island . .	14 3	74 32
	Barcalore Peak . .	13 50	74 58
	St. Mary's Rocks, N.P.	13 28	74 55
	— S. P. . . .	13 17	74 55
	Molky Pyramid . .	13 12	75 4
	Premeira. or Molky Rocks . . .	13 11	74 52
	MANGALORE . .	12 50	75 7
	Mount Dilly . .	11 59	75 31
	Canonore Point & Fort	11 51	75 41
	Tellicherry Flagstaff .	11 44	75 49
	Mahe Fort . . .	11 41	75 52
	Sacrifice Rock . .	11 30	75 51
	Calicut . . .	11 15	76 5
	Beypore River . .	11 10	76 6
	Paniany River . .	10 38	76 17
	Chitwa Church . .	10 33	76 20
	Cranganore or Aycotta River . . .	10 15	76 24
	Cochin . . .	9 57	76 29
	Alippee . . .	9 30	76 34
	Porca . . .	9 20	76 39
	Iviker or Aybicka .	8 54	76 46
	Quilon . . .	8 52	76 48
	Angenga Fort . .	8 39	77 00
	Ruttera Point . .	8 23	77 8
	Cadiapatam Point .	8 9	77. 29
	CAPE COMORIN .	8 5	77 44
	Ceylon . . .		
	— Point Pedro . .	9 49	80 23
	— Colombo . .	6 57	80 00
	— Adam's Peake .	6 52	80 38
	— Point de Galle .	6 1	80 20
	— Matura . . .	5 58	80 40
	— Dondra Head .	5 55	80 43
	— Grand Bassas . .	6 11	81 38
	— Little Bassas . .	6 24	81 55
Ceylon.	— Elephant Point .	6 20	81 39
	— Agaus or Aganis .	6 53	82 1
	— Battacola Roads .	7 44	81 52
	— Vendoos Bay . .	7 57	81 44
	— Trincomaley, Flagstaff Point . .	8 33	81 24
	— Molewal or Molateeva House . .	9 13	81 1
	— Point Palmyra .	9 49	80 26
	Manapa Point . .	8 22	78 16
	Trinchindere Pagoda .	8 30	78 24

		Lat. D. M.	Long. D. M.
Ceylon.	Punnecoil . . .	8 41N.	78 30E.
	Tutacarine . . .	8 50	78 32
	Point Ramen . .	9 17	79 22
	Deviapatam . .	9 29	79 00
	Tondy . . .	9 45	79 12
	Point Calymere . .	10 18	79 58
	—Pagoda . . .	10 23	80 00
	Negapatam Fort . .	10 45	79 55
	Five White Pagodas of Nagore . . .	10 49	79 55
	Tranquebar . .	11 1	79 55
	Devicotta (Exteroon R.)	11 22	79 54
	Porto-Novo . .	11 31	79 48
	Cuddalore . . .	11 43	79 50
	PONDICHERRY .	11 56	79 54
	Sadras . . .	12 32	80 13
	MADRAS, Fort St. George . . .	13 4	80 22
	Ennore . . .	13 15	80 24
	Pulicat . . .	13 25	80 24
	Armegon . . .	13 58	80 13
	Point Pennar . .	14 30	80 17
	Gondegam . . .	15 20	80 6
Coromandel Coast.	False Point Divy .	15 47	81 1
	Point Divy . . .	15 59	81 16
	MASULIPATAM .	16 11	81 13
	Narsapour Point . .	16 19	81 50
	Point Gordeware .	16 48	82 22
	Coringa . . .	16 49	82 17
	Jaggernautporam .	16 56	82 17
	Wattara . . .	17 26	82 55
	Vizagapatam . .	17 42	83 26
	Bimlipatam . .	17 53	83 37
	Chicacole R. . .	18 12	83 54
	Ganjam Flagstaff . .	19 22	85 10
	Manikpatam . .	19 40	85 39
	Jaggernaut Pagodas .	19 48	85 52
	Black Pagoda . .	19 52	86 6
	False Point . .	20 20	87 00
	Point Palmyras . .	20 41	87 13
	BALLASORE . .	21 30	87 10
	Ingerlee Pagoda . .	21 44	88 00
	Kedgeree . . .	21 51	88 6
	CALCUTTA (Fort William) . . .	22 34	88 26
	Chandernager . .	22 51	88 27
	Sager Point . .	21 35	88 11
	Light-house Point .	21 30	88 27
Bengal.	Tail Western Brace, S.P.	21 9	87 47
	Tail Western Sea Reef, S. P. . . .	21 00	88 3
	Tail Eastern Sea Reef, S. P. . . .	20 58	88 21
	Floating Light Vessel	21 2	88 25
	Tail of Sauger Sand, S.P.	21 00	88 37
	Codja Deep (Island)	21 27	88 34
	Islamabad or Chittagong	22 21	91 45
	Red Crab Island . .	22 28	91 52
	Dombuck or Elephant Point . . .	21 10	91 58
	St. Martin's Reef .	20 34	92 13
	Mosque Point, ent. Aracan . . .	20 15	92 38
	Terribles (mid.) . .	19 25	93 6
	Cheduba Pagoda . .	18 48	93 34
	Tree Island . .	18 26	93 45

		Lat.		Long.	
		D.	M.	D.	M.
	Foul Island	18	7N	93	56E.
	Church (or St. John's Rocks)	17	28	94	7
	Calventura Rocks	16	52	94	8
	Buffalo Rocks	16	21	94	12
	Cape Negrais	16	2	94	13
	Diamond Island	15	52	94	19
	Sunken I. (or La Guarda)	15	41	94	15
	Rangoon, or Pegu river entrance	16	29	96	25
	PEGU	18	00	96	52
	Martaban	16	28	97	30
	Tavay Point	13	33	98	6
Pegu.	Tavay Island	13	13	98	9
	Cabossa Island	12	46	97	29
	West Canister Island	12	40	97	25
	Tanasserim Island	12	36	97	30
	Mergui	12	12	98	24
	Tores Islands, western	11	50	97	3
	Small Rock	11	21	97	15
	Domel Island	11	10	97	57
	St. Matthew's I.	9	55	98	4
	Seyer's Islands, N. P.	8	43	97	48
	— S. P.	8	28	97	48
	Junkseylon I. N. P.	8	9	98	20
	— S. P.	7	46	98	20
	Parlis River	6	21	100	13
	Elephant's Mount	6	10	100	21
	Queda	6	6	100	17
	Prince of Wales' I. Fort Cornwallis	5	24	100	21
	Cape Caran	3	32	101	8
	Salangore Hill and Fort	3	20	101	18
	Pulo Callam or Colong, S. P.	2	56	101	16
	Parcelar Hill	2	52	101	29
	Parcelar Point	2	42	101	32
	Tanjong Tuan, (C. Rachado)	2	28	101	52
	Tanjong Clin or Peer Punjah	2	17	102	8
Malay.	Fisher's Island	2	13	102	12
	Malacca Fort	2	12	102	15
	Water Islands, southern	2	4	102	20
	Mount Mora or Moar	1	59	102	42
	Mount Formosa	1	49	102	56
	Mount Battoo Ballo	1	39	103	11
	Pulo Pisang	1	28	103	16
	Pulo Cocob	1	19	103	25
	Tanjong Booro	1	15	103	30
	Little Hill, or False Johore Hill	1	26	104	4
	Johore Hill	1	23	104	6
	Barbucet Hill	1	25	104	13
	Point ROMANIA	1	23	104	18
	False Barbucet Hill	1	30	104	16
	Romania Reef	1	25	104	25
	Eastern Bank, (outer part)	1	32	104	35
	Pulo Tingy	2	17	104	8
	Blair's Harbour	2	43	103	40
	Pulo Varela	3	16	103	47
	Pahan Road	3	31		
	Tingoram	4	12	103	18
	Howard's Shoal	4	14	103	31
	P. Brala, or Capas de Mer	4	47N.	103	37E.
	P. Capas de Terra	5	15	103	8
Malay.	Tringany River, ent.	5	21	103	4
	Great Redang Island	5	50	103	00
	Pulo Printian	6	4	102	40
	Calantan Road	6	13	102	17
	Cape Patani	7	4	101	51
	Pulo Lozin	7	19	102	42
	Pulo Cara	8	29	100	58
	Siam River, entrance	13	30	101	15
Siam.	JUTHIA or SIAM	14	18	101	13
	Cape Liant	12	27	101	37
	Pulo Way	9	55	103	40
	Pulo Oby False	8	40	104	34
	Pulo Oby	8	25	104	54
	Cambodia Point	8	35	104	56
	Cambodia River, W. en.	9	34	106	30
	Cape St. James (E. ent. Saigon R.)	10	17	107	4
	Cape Trivoane	10	21	107	16
	Point Babeck	10	30	107	33
	Brittos Bank, N. E. P.	10	32	107	56
	Cow Island	10	39	107	52
	Point Kega	10	41	108	4
	Point Vinay	10	54	108	19
	Mui-guio or Little Cape	11	4	108	31
	Point Lagan	11	9	108	40
	Pulo Ceicer de Terre	11	13	108	48
	Cape Padaran	11	21	109	00
	Padaran Bay	11	35	109	4
	Cape Varela False	11	44	109	12
	Carmaigne Harbour, en.	11	49	109	12
	Water Islands	12	3	109	19
	Tre Island	12	16	109	19
	Pyramid Island	12	21	109	19
	Nhiatrang	12	26	109	10
Cochin-China.	Three Kings Rocks	12	43	109	23
	Hone Cohe Harbour	12	45	109	12
	Cape Varela, or C. Pagoda	12	55	109	25
	Perforated Rock	12	59	109	25
	Phuyen Harbour, ent.	13	23	109	14
	Coumong Harbour, ent.	13	29	109	13
	Pulo Cambir	13	33	109	21
	Cape Sanho	13	44	109	14
	Quinhone Har.	13	50	109	14
	Buffalo I.	14	11	109	14
	Point Nuoc Ngol	14	19	109	7
	Tamquan River	14	39	108	56
	Pulo Canton	15	23	109	6
	Port Qui-quick	15	23	108	44
	Cham Callao	15	54	108	33
	Cape Turon or Tienchu	16	5	108	15
	Callaohanne I. (N. ent. Turon)	16	11	108	7
	Cape Chouvay	16	21	107	51
	Hue or Huesso River	16	35	107	26
	Tiger Island	16	55	107	23
	Hainan I. and adjacent Islands,				
	— Yaitchew Bay	18	24	108	52
	— Yulenken Bay, Zenby	18	11	109	35
	— South Pt. of Hainan	18	10	109	34
	— Galong Bay	18	12	109	39
	— Brother's I's. Eastern	18	11	109	41

		Lat. D. M.	Long. D. M.
	— Luengsoy Point S. P.	18 22N	110 00E.
	— Sail Rock . .	18 26	110 8
	— Saddle Island . .	18 35	110 11
	— Point of land . .	18 40	110 24
	— Nankin Island .	18 38	110 21
	— Tinhosa Island .	18 40	110 28
	— False Tinhosa .	18 49	110 34
	— Toongean Mount.pt.	19 35	111 2
	— HainanHead N.E.P.	19 59	110 54
	— South Taya Island .	19 49	111 12
	— North Taya Island .	19 59	111 17
Hainan I.	Nowchou . . .	20 58	110 26
	Ty-foong-kyoh I. (Tien-pak harb.) . .	21 22	111 13
	Ty-Chook-Chow I. .	21 26	111 25
	Song-yue Point . .	21 31	111 40
	Mamee-Chow, or the Twins, near S. W. P. of Hai-ling-shan .	21 34	111 50
	Ty-oa Point . .	21 43	112 15
	Nampang I. . .	21 34	112 12
	Mandarin's Cap . .	21 28	112 22
	Mong-chow I. . .	21 39	112 29
	Haw-cheun, S. W. end	21 35	112 31
	Passage I. (near S.W.P. Haw-cheun) . .	21 35	112 34
	Wy-Causs I. (near S. point St. John's)	21 34	112 47
	Lieu-Chew I. . .	21 36	112 52
	Wizard Rocks . .	21 47	113 1
	Ty-kam I. . . .	21 52	113 1
	Cou-cock I. . .	21 50	113 7
China.	Tyloo I. S. P. . .	21 52	113 14
	Great Ladrone . .	21 57	113 44
	Potoe or Passage I. .	22 2	113 39
	Laff-Samee Peak .	22 8	113 49
	Typa	22 8	113 33
	Macao, City . .	22 10	113 32
	Lantoa orTyho I. S.W.P.	22 12	113 50
	Lintin Island, Peak .	22 24	113 48
	Asses Ears . .	21 54	114 1
	Great Lema I. N. E. P.	22 5	114 18
	Nine Pin Rock . .	22 16	114 22
	Whampo anchorage .	23 6	113 22
	CANTON . . .	23 7	113 14

XLI. *Islands and Shoals in the INDIAN OCEAN, between the meridians of the Cape of Good Hope and Sumatra, including those West and North-West of New Holland.*

		Lat. D. M.	Long. D. M.
	Dutch Bank, Stot Van Capelle,		
	Various situations from	40 00S.	38 50E.
	— to	36 00	43 30
	Telamaque Shoal, (doubtful)		
	Various situations from	39 9	21 57
	— to	38 00	23 24
	Brunswick Bank,doubt.	37 25	36 19
	French Shoal, doubtful	38 8	43 6
	Atlanta's Rock, doubtful	36 43	52 00
	Wellington Shoal, very doubtful . .	39 53	71 43
	Prince Edward's islands		
	— Southernmost .	46 53S.	37 46E.
	— Northernmost .	46 40	38 8
	Kerguellan's Land, or Isle of Desolation,		
	— Bligh's Cap, N. P.	48 29	68 44
	— Christmas Harbour	48 41	69 4
	— Port Paliser . .	49 3	69 37
	— Cape Digby, or E. P.	49 23	70 34
	— Cape George, or S,P.	49 54	70 10
	— Island Solitaire .	49 49	68 11
	— Cape Louis . .	49 3	68 23
	St. Paul's (or Amsterdam Island) . .	37 52	77 52
	Amsterdam (orSt.Paul's Island) S. P. . .	38 47	77 52
	Danish Rock, doubtful	28 17	98 25
	Cloate's I. (lon. uncer.)	22 7	112 30
	Tryal Rocks . .	20 40	105 30
	RosemaryIslands } very near New Holland	20 23	115 55
	A reef 10 miles N.W. of Rose mary Island } very near New Holland	20 18	
	Abrohlos Shoals } very near New Holland	28 30	113 35
	Christmas Island .	10 33	105 33
	Cow Isles,		
	— Northern . .	11 50	97 4
	— Southern . .	12 23	97 15
	Clarke's Reef and Impericuse Shoal . .	17 32	119 14
	Dampier's or Scott's Reef, N. W. end .	13 52	121 59
	— N. E. end . .	14 1	122 16
	Coral Bank . .	13 32	124 29
	Coral Bank, 9 fathoms	13 25	124 12
	Coral Bank, 7 fath. .	12 46	124 32
	Cartier'sSandyI.orBank	12 28	123 56
	Red Island, (very near New Holland)	15 9	124 22
	Coral Bank. 10 f. or less	12 25	124 11
	Hibernia's Shoal . .	11 56	123 28
	Sahul Shoal, S. W. P. 12 fath.	11 35	124 14
	Echo's Soundings, 14 fath. . . .	11 16	125 50
	Coral 7 fath. Bank .	9 56	129 28
	Fortune Shoal . .	33 8	43 5
	Union Shoal . .	35 25	41 12
	Dutch Bank . .	31 44	44 00
	Otter's Shoal, doubtful	33 56	36 00
	Princess Augusta'sShoal doubtful . . .	33 44	36 16
	Union Rocks, doubtful	35 23	41 20
	Swallow Rocks&Breakers, doubtful . .	28 20	42 10
	Belliquese Shoal, doubt.	28 43	42 33
	Star Bank . . .	25 15	44 16
	Madagascar Island,		
	— Cape Amber, N. P.	12 2	49 25
	— Cape East . .	15 14	50 30
	— Bay Antongil . .	16 27	50 23
Madagascar I.	— St. Mary's Island .	17 00	50 25
	— Foul Point . .	17 41	49 36
	— Fort Dauphin . .	25 5	46 35
	— Cape St. Mary .	25 40	45 13

		Lat.		Long.	
		D.	M.	D.	M.
	— St. Augustine Bay ent. (Sandy I.)	23	39 S	44	00E.
	— Cape St. Vincent	21	46	43	50
	— Cape St. Andrew	16	2	45	16
	Madagascar Island				
	— Table Cape	15	43	46	6
	— Bembatooka Bay	15	43	46	28
	— Majambo Bay	15	10	47	6
	— Narrenda Bay	14	31	47	45
	— Dalrymple Bay	13	31	48	9
	— Passandava Bay	13	45	48	23
	— Cape St. Sebastian	12	28	48	54
Comoro Is.	Star Bank	25 25	7 25	44	16
	Bassas de India	22	28	40	37
	Europa Rocks	21	28	40	8
	Sussex Rocks	21	25	42	36
	Bazaruto Islands	21	20	36	12
	Barren Islands, western	18	26	44	15
	English Bank	17	40	40	15
	Juan de Nova or St. Christopher's I.	17	3	43	7
	Coffin Island	17	30	44	5
	Chesterfield Shoal	16	20	44	8
	Mayotta Island	12	54	45	14
	Mohilla Island	12	20	43	50
	Johanna Island, Peake	12	15	44	34
	Comoro	11	32	43	25
	Portuguese Shoals	12	30	46	50
	John Martin's Island (doubtful)	10	15	43	50
	Firebrass Bank	13	16	46	20
	Aldabra Islands, N.W.P.	9	23	45	46
	Assumption Island	9	46	47	16
	Cosmoledo Island	9	46	48	20
	Marquis of Huntley's Bank	9	57	50	20
	St. Peter's Island	9	28	50	42
	Natal Island (doubtful)	8	26	47	12
	Sandy Island	9	10	48	10
	St. Lawrence Island	9	13	50	58
	Zanzibar Island, S. P.	6	28	39	46
	— N. P.	5	40	39	46
	Amirante Island, N.W.P.	5	10	53	45
Mahe Bank.	— S. E. P.	6	20	54	30
	Mahe Bank, N. W. P.	3	20	54	40
	— S. E. P.	5	30	56	59
	— Seychelle or Mahe I.	4	35	55	35
	— Praslin I.	4	19	55	47
	French Shoal	3	58	54	42
	African Islands	4	55	54	9
	Alphonsa I.	7	4	52	49
	Sandy Island or Bank	7	16	52	49
	Isle Bourbon St. Denis	20	52	55	29
	Mauritius or I. of France				
	— Fort Louis	20	10	57	30
	Diego Rais or Rodrique	19	40	63	24
	St. Branden or Cargados Garajos				
	— N. part of the Bank	13	41	61	15
	— Low Sandy Island	16	5	59	47
	— Islet with huts	16	27	59	40
	— South Islet	16	47	59	34
	Nazareth Bank, S.W.P.	16	47	59	31
	— N. E. P.	13	41	61	15

		Lat.		Long.	
		D.	M.	D.	M.
	Sandy Island	15	52S.	55	23E.
	Galega or S. Roquepiz, mid.	10	25	56	39
	Saya de Malha Bank — limits	11 8	30 18	62 59	20 58
	Fortune Bank	7	12	57	40
	John de Nova	10	15	51	12
	Providence Island	9	9	53	00
	Coetivy Island	7	14	56	32
	Chagos Archipelago				
	— Diego Garcia	7 7	29 14	72	22
Chagos Archipelago.	— Pitts' Bank	7 6	29 50	71	25
	— Centurion's Bank	7	39	70	53
	— Ganges Bank	7	26	70	50
	— Owen's Bank	6	46	70	12
	— Egmont's, or Six Islands	6	37	71	24
	— Danger Island	6	21	71	18
	— Eagle Island	6	10	71	23
	— Three Brothers	6	9	71	35
	— Peros, Banhos Isl'ds.	5	22	71	53
	— Saloman's Islands	5	23	72	20
	— Sandy Islands	5	17	72	37
	— Speaker's Bank	5	00	72	26
	Pona Molubque Atoll, S. P.	0	41	73	20
	— N. W. P.	0	34	73	12
	— N. E. P.	0	33	73	25
	Addon Island (mid.)	0	21	73	35
	Suadiva, southern group				
	— South Reef	0	9N.	73	15
	— South Island	0	11	73	12
	— S. W. Island	0	18	73	4
	— N. W. Island	0	28	73	2
	— N. Island	0	34	73	8
	— Northern group, S. W. Island	0	48	73	19
	— N. W. Island	0	51	73	20
	— N. E. Island	0	58	73	33
	Adoumatis Atoll				
	— S. W. extremity	1	50	73	27
Maldiva Archipelago.	— Southernmost Island	1	49	73	33
	— Island	1	51	73	38
	— N. W. Island	2	7	73	35
	— N. E. Island	2	9	73	46
	Collomandous Atoll				
	— South Island	2	13	73	21
	— Long Island	2	21	73	8
	— N. W. extremity	2	30	73	8
	— West entrance of Coll Channel	2	10	73	21
	Molucque Atoll	2	58	73	45
	Nillmandous Atoll	3	12	73	18
	Poulisdous Atoll	3	36	73	44
	Ari Atoll, W. P.	4	17	73	2
	Male Atoll or Maldivia, S. E. P.	4	13	73	42
	Gafer Island	4	46	73	40
	Todu Island	4	42	73	14
	Cordivia Island	5	00	73	36
	Maloss Madoll	5	00	73	12
	Padipolo Atoll. S. P.	5	13	73	32

		Lat. D. M.	Long. D. M.
Laccadive Archipelago.	Milla Doue Madou	6 5N.	73 13E.
	Tilla Dou Matis, or head of the Islands, northern limit	7 6	73 7
	Minicoy or Malicoy	8 17	73 18
	Seuvelli Islands, southern	10 00	72 36
	— Northern	10 6	72 39
	— Southern extreme Reef	9 54	72 34
	Kalpeni Islands, S. P.	10 4	73 56
	— N. P.	10 10	73 56
	Courutee Island	10 34	73 00
	Pittie Sand Bank	10 48	72 51
	Underoot I.	10 48	74 00
	Aucutta I.	10 51	72 31
	Bingaro I.	10 55	72 36
	Tingaro I.	10 55	72 38
	Ameni I.	11 6	73 8
	Permulpar I.	11 9	72 28
	Cardamum I. (mid.)	11 14	73 12
	Elicapeni Bank (mid.)	11 15	74 20
	Kittan I.	11 29	73 24
	Betrapar I.	11 35	72 34
	Chittae I.	11 42	73 4
	Cherbaniano Bank (not explored)	12 20	72 15
	Angrias Bank, N. P.	16 38	72 8
	— S. P.	16 18	72 8
	Bale of Cotton Rock (doubtful)	5 18	88 20
	Le Meme's Reef (doubt.)	1 20	94 20
Andaman Islands.	Preparis Island, N. P.	14 56	93 40
	— S. P.	14 49	93 40
	Great Coco I. N. P.	14 8	93 26
	— S. P.	14 2	93 26
	Little Coco I.	13 58	93 20
	Landfall I.	13 39	93 8
	Great Andaman		
	— Cape Price, N. end	13 34	93 9
	— S. E. point	11 30	92 56
	— Port Cornwallis	13 18	93 3
	— Port Chatham	11 41	92 50
	— Port Campbell	11 56	92 39
	Rutland, I. S. P.	11 24	92 47
	Interview I. N. P.	13 1	92 46
	— S. P.	12 47	92 41
	North Centinel	11 33	92 24
	South or Little Centinel	11 00	92 27
	Five Islands, S. P.	11 17	92 55
	Sisters, southern	11 10	92 58
	Brothers, northern	11 00	92 55
	Little Andaman, N. P.	10 53	92 38
	— S. E. P.	10 26	92 40
Nicobar Islands.	Invisible Bank, N. P.	11 27	93 41
	— S. P.	10 56	93 40
	— Flat Rock	11 8	93 40
	Barren Island	12 16	93 54
	Narcondam	13 24	94 12
	Car Nicobar	9 10	92 56
	Batty Maloc	8 46	93 1
Nicobar Islands	Chowry I.	8 28N.	93 12E.
	Terressa I. N. P.	8 22	93 17
	— S. P.	8 12	93 21
	Katchall, W. end	7 54	93 29
	Noncowry I. & harbour	8 00	93 41
	Camorta, N. P.	8 15	93 42
	Tillangchong Isls. N. P.	8 33	93 46
	— S. P.	8 22	93 46
	Meroe I.	7 29	93 46
	Little Nicobar, N. P.	7 26	93 52
	— S. P.	7 13	93 46
	Great Nicobar, N. P.	7 8	93 55
	— S. P.	6 45	94 00

XLII. *The Islands of Sumatra, Java, Billington, Gaspar, Banca, with the adjacent Islands and Straits.*

		Lat. D. M.	Long. D. M.
Sumatra.	Acheen	5 34N.	95 26E.
	Golden Mountain	5 27	95 49
	Podir Point	5 29	96 10
	Elephant Mountain	5 3	96 50
	Tooloo-Samwoi Point	5 13	97 22
	Diamond Point	5 18	97 48
	Tanjong Bou	1 5S.	104 30
	Batacarang Point	2 00	104 53
	Fourth Point	2 20	105 15
	Third Point	2 23	105 32
	Second Point	2 41	105 41
	First Point	3 00	105 58
	Hog Point	5 54	105 53
	Flat Point	6 00	104 40
	Billimbing Bay	5 54	
	Bencoont	5 35	104 25
	Cawoor	4 56	103 25
	Manna Point	4 33	102 53
	Buffalo Point	3 58	102 30
	BENCOLEN (Fort Marlbrough)	3 48	102 28
	Caytone	3 29	102 14
	Moco-Moco	2 34	101 26
	Indrapor Point	2 5	100 55
	Padang Head	0 56	99 58
	Priaman	0 40	99 53
	Natal	0 30N	98 40
	Tappanoly	1 40	98 40
	Tappoos	2 00	97 57
	Sinkel River	2 13	97 22
	Troumode	2 46	97 44
	Point Labon	3 2	97 22
	Point Tampot Tuon	3 15	97 16
	South Tally Pow	3 22	97 11
	Muckie	3 28	97 4
	LaboinHadje	3 32	96 59
	Mingin	3 35	96 55
	North Tally Pow	3 36	96 56
	TangarTangar	3 38	96 56
	Soosoo	3 42	96 50
	QuallahBattoo	3 43	96 43
	Cape Felix	3 43	96 27
	Analabo	4 9	96 6
	PuloRondo	6 4	95 14
	PuloWay	5 49	95 23
	PuloBrasse	5 42	95 6

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Pulo Rajah .	4	40N.		
	N. Cocos Islands lying N. W. of the North point of Hog Island	3	2	95	52E.
	Hog Island, N. P.	2	58	96	4
	— S. P. . .	2	22	96	32
	Coral Bank .	3	31	96	42
	Burgh Rock .	2	47	97	26
	Shoal, 10 feet .	2	48	97	33
	Castlereagh Shoal	3	5	97	6
	North Pulo Dua	2	52	97	39
	Passage Island .	2	21		
	Bird Island . .	1	56		
	Lucotta Island .	1	50		
	Londise Shoal (N.N.E. ½ E. from Lucotta, dist. 2½ leagues)	1	57		
	Mensular Island	1	32	98	20
	Pulo Dua . .	1	24	97	52
	Pulo Nyas, S. P.	0	33	97	21
	Pulo Tamong .	0	24	98	40
Islands W. of Sumatra.	Pulo Panjang .	0	13	98	30
	Clappe's Island, middle	0	8S.	97	30
	Pulo Mintaon, or Batao	0	21	98	7
	Pulo Ayer Besar	1	24	100	17
	Se-beero or G. Fortune I. N. P. .	0	56	98	38
	— S. W. P. .	1	47	99	2
	Se-pora or South Pora, N. W. P. .	2	00	99	33
	— S. P. . .	2	25	99	58
	North Poggy Isl. N. P.	2	32	100	5
	— S. P. . .	2	52	100	13
	South Poggy Isl. N. P.	2	50	100	15
	— S. P. . .	3	20	100	34
	Laage or Larg Islands	3	30	101	11
	Rat Island .	3	51	102	23
	Trieste or Reefs Island	4	3	101	22
	Pulo Pisang .	5	8	104	6
	Little Fortune Island	5	54	104	38
	Engano or Deceit I. N. P.	5	15	102	25
	— E. point .	5	22	102	40
	— S. E. point .	5	30	102	38
	— S. point .	5	31	102	29
	— W. point .	5	21	102	19
	Java Head .	6	48	105	11
	First Point .	6	44	105	12
	Second Point .	6	36	105	21
	Third Point .	6	27	105	40
	Anger . .	6	3	105	54
	Bantam or St. Nicholas P.	5	53	106	2
	Bantam . . .	6	5	106	10
	BATAVIA Observatory	6	9	106	52
	Carawang Point	6	1	107	12
	Sedary Point .	5	59	107	27
	Point Pamanoekan	6	11	107	49
	Woerden Castle Rock	6	2	107	52
	Princess Charlotte Shoal	5	58	107	54
	Indramaye Point	6	15	108	20
Java.	Pulo Rackit .	5	56	108	22
	Bumkin's Island or outer Shoal .	5	47	108	23
	Cheribon Mountain .			108	26
	Taggal . . .	6	50	104	14

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Taggal Rock .	6	46S.		
	Samarang flagstaff	6	57	110	25E.
	— anchorage .	6	53	110	24
	Mandalique Island	6	22	110	51
	Lerang Point .	6	35	111	27
	Rambang .	6	42	111	19
	Point Panka or Panco	6	52	112	34
	Sourabaye .	7	15	112	48
	Cape Sandana .	7	49	114	22
	Balambonang Bay, Pt. Goonog Ikan	8	23	114	25
	— East point .	8	46	114	33
	Turtle Bay .	7	48	109	48
Java.	Tulan or Dirck Vrie's Bay	7	50	108	12
	Wine Cooper's point .	7	28	106	36
	Noesa Baron I. .	8	38	113	35
	Tangala Islands, largest	8	26	112	26
	Clappe's Island, about	7	4	105	29
	Mew Island .	6	43	105	15
	Peak on Prince's Island	6	35	105	15
	Peak on Crocatoo island	6	8	105	25
	Peak on Tamarind Isl. or Pulo Bessy	5	56	105	28
	Pulo Sebooko .	5	53	105	26
	Cap . .	5	59	105	57
	Button . .	5	51	105	57
	Thwart-the-way .	5	55	105	51
	Zutphen Islands (largest) N. P. .	5	50	105	47
	South Watcher	5	41	106	43
St. of Sunda.	Maneater's Island	5	54	106	30
	Pulo Baby .	5	48	106	14
	Thousand Islands, N.	5	22	106	18
	Pruysen's Droogte shoal	5	17	106	47
	Armuyden Bank	5	13	106	48
	North Watcher .	5	12	106	32
	Three Sisters .	5	44	105	48
	North Island .	5	41	105	49
	Two Brothers, northern	5	9	106	5
	Lynn Shoal .	5	12	106	13
Banca St.	Shabunder Shoal	5	9	105	58
	Brouwer's Shoal	5	5	106	14
	Lucepera, S ent. St. Banca	3	12	106	10
	Nanka Islands .	2	25	105	48
	Banca Island . .				
	— South Point .	3	6	106	40
	— Tanjong Panjong or Point Lalary	2	49	106	4
	— Monopin Hill .	2	00	105	14
	Tanjong Goonting	1	43	105	20
	— Tanjong Muncooda, N. of Banca	1	28	105	51
	— Tanjong Tuan	1	38	106	6
	— Songy Leat Bay	1	50	106	9
	— Tanjong Ryah	1	55	106	14
	— Goonong Marass Mount .	1	53	105	52
Banca I.	— Tanjong Breket	2	36	106	52
	— Rocky Point .	2	56	106	54
	— Entrance Point, or S. E. P. .	3	2	106	54

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Essex Shoal or Fairlie Rock . . .	3	27S.	107	2E.
	Vansittart's Shoals	3	11	107	2
		3	5	107	8
	Pulo Leat or Middle I.	2	51	107	5
	Alceste Shoal .	2	46	107	2
	Shoal Water Island .	3	20	107	13
	South Island . .	3	00	107	15
	North Island . .	2	58	107	15
	General Hewitt's Rock	2	53	107	14
	Discovery Rock . .	2	54	106	56
	Pulo Glassa or Gasper I.	2	25	107	6
	Tree Island . .	2	28	107	00
	Warren Hasting's Shoal	2	23	106	57
	Belvidere's Shoal .	2	15	107	00
Gaspar St.	Vansittart's Shoal .	2	11	106	46
	Hillsborough Shoal .	2	3	106	22
	Magdalen's Shoal .	1	56	107	1
	Severn's Shoal . .	1	40	106	26
	Billiton Island, S. E. P.	3	22	108	15
	—S. W. Point . .	3	15	107	35
	—N. P.	2	33	107	53
	N. W. Island off Billiton	2	35		
	Shoe Island (formerly Bird I. and White R.)	3	47	108	2
	Fox Shoal . .	3	32	110	4
	Pulo Mancap . .	3	5	110	11
	P. Mancap Shoal, S. P.	3	22	110	11
	Discovery's West. Bank	3	39	108	43
	— Eastern Bank .	3	33	109	10
	— Reef	3	36	108	48
	Osterly's North Shoal .	3	19	108	40
	Cirencester's Sand Bank	3	17	109	5
	— Shoal	2	54	108	58
	Montaran Islands south	2	35		
	— Eastern . .	2	31	108	52
	— Toekoekemou (highest Isl.) . .	2	31	108	36
	Minto Rocks . .	2	14	109	51
	Ontario's Shoal . .	2	1	108	39
	Rendezvous I. . .	2	44	110	3
	Souroutou, W. P. .	1	42	108	41
	Carimata I. Peak .	1	36	108	54
Billiton St.	Pulo Papan . .	1	28	109	26
	Pulo Panumbangan .	1	12	109	14
	Massa Teega Isles .	0	55	109	18
	Greig's Shoal . .	0	55	108	39
	TheSeven Islands,N.W.	1	8	105	24
	Pulo Varela or Barallab	0	54	104	20
	Pulo Taya . .	0	45	104	58
	The Calantigas . . .	0	35	103	51
	Ilchister Shoal . .	0	26	105	2
	Lingin, Tanjong Eang, S. E. ext. . .	0	20	105	4
	East Domino Island .	0	10	105	4
	Geldrias Bank, same as Dogger Bank . .	0	48N.	104	58
	Rhio	0	57	104	30
	Eastern Island off Pulo Panjang . .	0	54	104	56
	Island	0	48	104	51
Sincapore St.	Three Brothers, south .	0	31	103	44
	Pedro Branco . .	1	20	104	26
	Islands off P. Romaine	1	23	104	20
	Bintang I. (the hill) .	1	2	104	30

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Bintang I. N. W. P. .	1	10N.	104	19E.
	Johore Shoal . .	1	18	104	4
	Shoal ent. Rhio Straits	1	8	104	11
	Sincapour I. E. P. .	1	22	104	00
	Pulo Battain, N. E. P. .	1	10	104	4
	St. John's I. S. P. .	1	14	103	51
	Rocky Reefs . . .	1	9	103	55
	Middle Island . .	1	13	103	46
	Coney Island . .	1	9	103	41
	Buffalo Rock . .	1	9	103	48
	Rocks	1	6	103	45
	Red Island . .	1	6	103	38
	Tree Island . .	1	8	103	36
	Alligator Island . .	1	10	103	40
	Rocks	1	12	103	36
	Little Carimon . .	1	8	103	24
	Great Carimon, N. P. .	1	7	103	21
Sincapare St.	The Brothers . .	1	10	103	21
	Pulo Cocob . .	1	19S.	103	25
	Pulo Pisang . .	1	28	103	16
	Water Islands, or Four Brothers, S. P. .	2	4	102	20
	Fisher's Island . .	2	13	102	12
	Bambeck Shoal . .	2	37	101	41
	Pulo Callam or Colong, S. P.	2	56	101	16
	Two and half fathoms Bank . . .	2	54	101	4
	Round Arroa . .	2	49	100	49
	Blenheim's Shoal .	3	3	101	2
	Long or Great Arroa .	2	52	100	44
	Two Brothers, Pulo Pandan . .	3	24	99	54
	— Pulo Salanama .	3	21	99	52
	Pulo Varela . .	3	47	99	36
	Pulo Jarra . .	4	00	100	14
	Sambilang I. Southern	4	3	100	35
	Dinding I. W. P. .	4	16	100	35
	Prince of Wales' I. Fort Cornwallis . .	5	24	100	21
	Pulo Pera . .	5	42	99	1
	Boonting I. Southern .	5	45	100	18
Malacca St.	Pulo Bonton (Dome)	6	33	99	20
	Pulo Ladda, S. P. .	6	8	99	42
	Trotto I. N. P. . .	6	49	99	39
	Sangald or Guilder Rock	7	10	98	50
	Pulo Telibon .	7	14	99	29
	The Brothers . .	7	31	98	20
	Pulo Rajah or P. Taya	7	36	98	20
	Junkseylon, S. P. .	7	46	98	20

XLIII. *Islands and Shoals in the CHIN SEA.*

		Lat. D.	Lat. M.	Long. D.	Long. M.
	St. Barbe Island .	0	7N.	107	15E
	Direction Island .	0	15	108	5
	Pulo Datoo . .	0	7	108	36
	Welstead's Rock .	0	32	107	55
Tambelan I.	St. Esprit Islands, E. .	0	34	107	13
	Green Island . .	0	43	107	30
	St. Julian Island .	0	54	106	48
	Tambelan Islands, East or Great I. .	1	00	107	35
	Gap Rock . .	1	12	107	35
	Europe Shoal . .	1	12	107	26

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Rocky Island	1	9N.	107	14E.
	Camel's Hump	1	10	106	55
	Saddle Island	1	16	107	4
	French White Rock	1	32	106	32
	Victory Island	1	34	106	22
	Acàstee Rock	1	39	106	21
	White Rock	2	18	105	35
	Macedonian Reef	2	25	105	32
	South Anambas, limits	2	18	106	8
		2	40	106	30
	Pulo Domar	2	45	105	27
	Middle or G. Anambas, W. limit	3	9	105	41
	North Anambas	3	27	106	15
Anambas I.	Pulo Tingy	2	17	104	8
	Ex. Islet off P. Tingy	2	8	104	11
	Pulo AOR or Wawoor	2	29	104	35
	Pulo Pisang or Pambeelan	2	37	104	21
	Pulo Timoan, S. P.	2	44	104	15
	— N. P.	2	54	104	15
	— Bay on S. W. side	2	48		
	— N. Islet off N.W. side	2	56		
	Pulo Varela	3	16	103	47
	Pulo Brala or Capas de Terre	4	47	103	37
	Pulo Capas de Terre	5	15	103	8
	St. Pierre Islands	1	56	108	53
	— Ledge of Rocks	1	53	108	52
	Larkin's Reef	2	11	109	16
	South Haycock Island	2	13	108	57
Natunas Islands.	South Natuna's Islands				
	— South Island or Sapata	2	28	109	8
	— East Island	2	42	109	26
	— West Island	2	42	108	40
	— North or Flat Island	3	3	108	54
	Low Island	3	00	107	49
	Hutton's Shoal	3	2	107	57
	Diana Shoal	3	9	107	44
	North Haycock Island	3	20	107	36
	Grand or Great Natuna I. limits	3	40	108	26
		4	13	108	6
	—Peaked Island	3	54	108	10
	Pyramidal Rocks	4	5	107	24
	— N. W. Island	4	7	107	52
	— Coral Reef	4	1	107	50
	— Coral Reef	3	57	107	47
	North Natuna Is. S. P.	4	42	107	58
	— N. P.	4	49	108	2
	— Rock above Water	4	39	107	57
	— Saddle Island	4	33	107	46
	— Success Shoal	4	25	107	57
	Pulo Oby	8	25	104	54
	The Brothers (eastern)	8	35	106	18
	Pulo CONDORE	8	40	106	42
	Charlotte's Bank	7	5	107	39
	Phæton Bank	7	00	107	29
	Royal Bishop's Bank	9	44	108	21
	Britto's Bank, N. E. P.	10	32	107	56
	Hollond's Bank, S.W.P.	10	36	108	32
	— N. E. P.	10	48	108	47
	Pulo SAPATA	10	1	109	2
	Pyramid Rock or Little Catwick	10	2	109	00

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Round Island or Great Catwick	10	6N.	108	52E.
	Pulo Ceicer de Mer	10	32	108	53
	Minerva's Bank	10	37	110	18
	———				
	Investigator's Coral Patch	14	12	112	52
	Triton's I. or Bank S. W. part	15	45	111	11
	Passoo Keah (Sandy I.	16	3	111	45
	Bombay Merchant's Shoal, E. P.	16	4	112	38
	—S. P.	15	59	112	26
	Discovery Shoal, W. P.	16	11	111	32
	— E. P.	16	16	111	46
	Jehangire's Coral Bank	16	18	112	35
	Vulador's Shoal, E. P.	16	19	112	7
	— W. P.	16	18	112	00
	Crescent Chain				
	— Money's Island	16	28	111	30
	— Robert's Island	16	31	111	34
	— Pattle's Island	16	33	111	36
Paracels.	— Drummonds's Island	16	29	111	44
	— Governor Duncan's Island	16	27	111	40
	— Antelope's shoal	16	27	111	35
	Observation Bank N. P.	16	37	111	41
	Pyramid Rock	16	35	112	37
	Lincoln Island	16	41	112	42
	Rocky Island	16	52	112	20
	Woody Island	16	50	112	18
	AmphitriteIslands, W.P.	16	59	112	12
	— E. P.	16	54	112	23
	North Shoal, W. P.	17	5	111	26
	— E. P.	17	6	111	32
	———				
	Macclesfield Bank, limits	15	17	113	44
		16	21	114	54
	Scarborough or Marsingola Shoal, limits	15	4	117	44
		15	13	117	53
	St. Esprit Shoal (by Lt. Ross)	19	30	113	6
	— (by Asseveido)	19	6	113	5
	Pratas or Prater's Shoal N. E. P.	20	47	116	54
Pratas.	— N. W. P.	20	45	116	42
	— Anchorage	20	43	116	42
	— Island	20	43	116	45
	Great Ladrone	21	57	113	44
	[The Islands near Canton are given in No. XL. and in No. XLVI.]				
	Pedro Branco	22	19	115	8
	Lamock Islands, outermost	23	14	117	19
	———				
	Andrade Rock (very doubtful)	9	56	111	4
	Luconias Shoals				
S. E. Part China Sea.	— Hard Rocks	5	24	112	30
	— Two Fathom Shoal	5	6	112	24
	— Dry Sand	4	57	112	30
	Sea Horse Reef	5	35	112	25
	— Half Moon Breakers	8	46	116	30
	— Bank	10	57	117	58

S. E. Part of China Sea.

	Lat. D. M.	Long. D. M.
Paraquas, 5 or 6 leagues from Palawan . .	9 10N.	117 28E.
Euphrates Shoal . .	5 38	113 24
Kirton's Shoals . .	5 39	113 15
— ditto . . .	5 49	113 2
Louisa's Breakers .	6 20	113 18
Mantannane Isles .	6 39	116 7
Barton's Shoals . .	6 55	116 6
Royal Charlotte's Rocks	6 57	113 38
— Sands . . .	10 47	114 29
Swallow or Investigator's Rocks . .	7 23	113 44
Viper's Bank . .	7 30	115 7
— Breakers . .	8 00	115 25
Ardasier's large coral flats and gaps . .		
— W. P. (Walpole, Cornwallis and A.)	7 56	113 12
— N. E. P. (Walpole and A.) . .	7 54	114 24
— E. P. (Ardasier) .	7 40	114 47
— S. P. (Pennsylvania and A.) . .	7 30	114 34
Gloucester Shoal .	7 47	114 50
Stag's Shoal . .	8 24	112 57
Prince of Wales Bank limits	8 3	110 24
	8 13	110 34
London Breakers .	9 36	112 26
— Reef, western . .	8 55	112 00
— do. eastern . .	8 48	112 24
— Breakers . .	7 33	113 14
— ditto . . .	7 22	113 8
Ganges Breakers . .	9 22	114 12
— ditto . . .	10 30	115 10
Investigator's Shoal W. P	8 5	114 35
— E. P. . .	8 10	114 51
— Shoal . . .	9 12	116 32
— Shoal . . .	10 44	114 34
— Coral Rocks .	9 40	113 4
ditto .	9 42	113 15
Cavallo Marino's Shoal	5 54	114 18
— ditto . . .	8 31	114 21
— Black Rocks . .	9 39	114 58
— Bank . . .	10 18	115 7
— White Sand . .	10 48	115 13
— Low Black Island .	11 1	115 17
Friendship's Shoal	5 52	112 34
	6 00	112 49
Hardwick's Reef* (or Dolphin's) .	9 54	112 17
— Breaker's* (ditto) .	10 2	112 12
Royal Captain's Shoal	9 4	116 43
Bombay's Shoal . .	9 27	116 55
Dolphin's Reef* (or Hardwicke's) .	9 59	112 17
— Breakers* . .	9 45	112 30
— Breakers* (ditto) .	10 8	112 15
— Great Reef, N. P.*	10 7	112 9
— Long Island* . .	10 17	112 35
— Breakers* . .	10 22	112 31
— First Island* . .	10 35	112 38
— Ledge* . . .	10 40	112 47
— Breakers* . .	10 46	112 47

* The longitudes of these places ought probably to be increased.

S. E. Part of China Sea.

	Lat. D. M.	Long. D. M.
Breakers* . . .	11 10N.	112 54E.
Falmouth's (or Essex) low Island*) .	10 58	112 40
— Bank, or Gossard's B.	11 25	114 13
Essex (or Falmouth) low Island* .	11 2	112 40
Gossard's Reef (or Middleburg R.) . .	8 58	111 5
— Small Island . .	10 42	113 26
Cornwallis Breakers .	10 00	114 26
— ditto . . .	8 49	114 14
Sabut Jung low Island	11 32	113 29
— Bank . . .	11 34	113 51
Gaspar Shoals . .	11 36	113 51
South Sea Castle's Sandy Islands and dangers, limits (by Lieut. Ross) . . .	11 29	114 24
— do. . . .	11 21	114 16
Two Islands . .	11 27	114 22
An Island (Investigator)	11 8	114 18
An Island ditto .	10 44	114 26
A Reef . . .	10 15	113 40
Discovery's Reef .	10 00	113 50
	10 8	
York Breakers . .	9 50	117 48
Pennsylvania Breakers	8 17	114 43
— ditto . . .	8 48	115 17
— ditto (Viper's) .	8 58	115 21
— ditto . . .	9 4	115 17
— ditto . . .	10 00	115 20
— ditto (Fanny) .	9 45	114 49
— ditto . . .	9 32	116 34
— ditto . . .	9 47	116 58
— ditto . . .	9 52	116 48
— ditto . . .	10 23	116 49
— ditto . . .	10 49	117 10

XLIV. *Islands and Shoals between Batavia and New Guinea, South of the Celebes.*

Java Sea.

	Lat. D. M.	Long. D. M.
Carimon Java .	5 50S.	110 34E.
Lubeck or Babian Island	5 49	112 48
Arrogant's Shoal .	5 12	113 00
Madura I. N. W. P. .	6 53	112 45
— N. E. P. . .	6 53	113 58
Pondy Island . .	7 1	114 4
Great Solombo I. (Hill on S. E. P.)	5 33	114 28
Little Solombo I. .	5 24	114 28
Arentes Island . .	5 10	114 36
Little Pulo Laut (mid.)	4 51	115 53
Four Brothers, sunken islands . . .	7 00	114 50
Urk Island . , .	7 15	115 13
Kangelang or Cangayang I. N. P. . .	6 53	115 17
— S. P. . . .	7 19	115 25
— S. E. I. or Hasting's Island . . .	6 56	116 24
Kalkoon Islands, northern, about . .	6 10	115 35
Four small islands mid.	7 11	115 50

	Lat. D. M.	Long. D. M.
Great Paternoster's Is. W. P.	7 15S.	117 00E.
— S. W. I.	7 32	117 16
— S. I.	7 34	117 30
— Two low islands	7 36	117 55
— E. P.	6 42	118 40
Postillion's Islands, N. W. P.	6 32	118 48
— Eastern Island	6 45	119 15
— ditto, S. P.	6 55	119 5
Noesa Sera Islands	5 2	117 9
Noesa Comba, about	5 15	117 9
S.Bank off NoesaComba	5 46	117 00
Calocohij or Rotterdam I	5 15	117 36
Hen & Chickens, S. P.	5 28	117 54
Zalinaff or Saflanaff or Laer's I.	5 31	118 25
— Coral Bank off ditto, S. P.	5 54	
— ditto, E. P.		118 26
— ditto, W. P.		117 58
— Five Fathoms Bank	5 52	118 20
Tonyn Islands, S. W. I.	5 31	118 36
— E. I.	5 31	118 46
Shoal	5 27	119 5
Tanakeka or Tunikik I.	5 34	119 24
Brill Shoal, N. P.	6 00	119 2
— S. P.	6 5	119 00
Mansfield Shoal	5 45	120 13
Middle Island	5 40	120 28
Salayer I. N. P.	5 49	120 28
Cambyna I. S. P.	5 30	
— Peak	5 21	121 1
South Island	5 40	122 30
Hegadis Island	6 13	122 40
Bouton Island, S. P.	5 42	122 44
— Town	5 27	122 48
— N. E. Point	4 23	123 4
— Calansoese Harbour	4 55	123 11
— East Point	5 15	123 15
Token Bessy's Islands,		
— Wangiwangi, N.W I.	5 15	123 33
— Pinnunko S. P.	6 14	124 1
— Velthoens or Koko I.	5 58	124 48
— ditto	6 10	
St. Matthew's Islands, (mid.)	5 18	124 16
Mamalakjee I. (N. W. Tonin I.)	6 41	120 14
Schiedam Islands, N.W.	7 1	120 28
— S. E.	7 12	120 56
— Shoal	7 27	121 13
Kalatoa Island	7 12	121 40
Alfred's Shoal	7 9	121 36
Jagger's Reef or Bangalore Shoal, about	7 40	121 13
— ditto, another estimate		121 46
Angelica's Shoal	7 35	121 58
— ditto, another estimate	7 40	122 18
Rusa Raji or Lusardy I.	8 17	121 38
Rusa Linguette or Rosagalet I.	8 5	122 00
The Three Bastards	8 14	122 41

Straits East of Java.

	Lat. D. M.	Long. D. M.
Bally Island,		
— Table Point or S. P.	8 50S.	115 2E.
— Volcano	8 24	115 24
— N. E. P.	8 18	115 43
Bally Straits, S. ent.	8 50	114 40
A shoal near the anchorage at Balambuang, bears S. W.¼ W from the flagstaff, distant ¾ mile from shore		
Mynder's Rocks	7 41	114 22
Banditti Island	8 46	115 15
Lombock I. S. P. about	8 50	116 00
— Peak, near N. E. P.	8 21	116 26
— North Point	8 11	
Lombock I.		
— Isles near N. W. P.	8 13	115 59
— Ampannan Riv. ent.	8 33	
— Loboagee or Bally Town	8 42	116 33
Selonda Island	8 8	117 44
Pulo Majo or Mayo N.P.	8 7	117 31
Flat Island	8 9	117 25
Sandbuy's 4 Shoals, limits	7 42 7 56	117 13 118 3
Sumbava I. S. W. P.	9 2	116 42
— Timor Yung I. (off N. W. P.)	8 21	116 57
— Sumbava Bay	8 27	117 24
— Tumbora Mountain	8 9	117 43
— Biema Bay, rugged point	8 11	118 51
— ditto, rocky point	8 8	118 36
— Sapy Bay, anchorage	8 30	119 3
— S. E. Point	8 42	119 14
Goonong Apee I. Peak	8 11	119 5
Comodo Island	8 22	119 37
Flores or Mangerye I. S. W. P. about	8 50	
— S. P. about	9 00	121 30
— Lobetobie Volcano	8 32	
— N. P. Flores Head, or Iron Cape	8 5	123 2
Straits of Flores, S. en.	8 40	123 3
Sandal Wood I N. P.	9 15	
— Bluff or West P.	9 42	119 00
— S. extremity	10 22	120 20
— E. end	10 00	120 35
— Padewawy or Baring's Bay	9 37	120 20
Savu Island	10 37	122 00
New Island	10 46	121 3
Pulo Comba or Cambay	7 49	123 41
Lomblen I. Peak (on N. W. P.)	8 12	123 52
— E. Point	8 14	124 00
Pantar I. N. E. P.	8 10	124 5
East Island, Str. of Aloo	8 20	124 00
Middle Island, ditto	8 23	123 55
Ombay or Mallao I. N. W. P.	8 9	124 27
— E. P.	8 17	125 15
Rotto or Rotte I. S.W.P.	11 2	122 55

		Lat. D. M.	Long. D. M.
Timor I.	— Booca Bay on S. side	10 46 S.	123 20E.
	Timor Island, S. W. P.	10 23	123 30
	— Copang, Fort Concordia . . .	10 9	123 35
	— Peak . . .	9 41	124 11
	— N. W. Point . .	9 24	123 55
	— Tulycaon Bay .	9 12	124 23
	— Batto-gady . .	8 57	124 55
	— Point nearest Ombay	8 39	125 13
	— Dilly or Diely	8 35	125 40
	— East end . .	8 21	127 15
	Pulo Batto . . .	9 16	124 5
	Pulo Cambing or Passage I. S. P. . .	8 21	125 39
	— N. P.	8 11	125 43
	Wetter Island, E. P. .	7 46	126 54
	— Pulo Baby, near S. W. P. . . .	5	
	Goonong apy or Burning I. . . .	6 35	126 40
	Dog Island . . .	7 41	126 3
	Kisser Island . .	8 00	127 7
	Pulo Jackee or Noosa Nessing . . .	8 19	127 18
	Lettee I. W. P. . .	8 16	127 46
	Roma Island . .	7 39	127 30
	Lucapin-hay or Lucepera I. . . .	5 40	127 21
	Turtle Islands, eastern	5 25	127 38
	Cerowa Island, about	6 10	129 53
	Babber Island, about .	7 25	130 40
	Timor Laut, S. P. .	8 15	131 50
	Arroe Island, S. ext. .	9 00	135 00

XLV. *Borneo, Celebes, Luconia, with the adjacent Islands and Shoals, as far east as New Guinea.*

		Lat. D. M.	Long. D. M.
Borneo.	Tanjong Sambar, SW.P.	2 53 S.	110 14E.
	Succadana . . .	1 16	110 7
	Tanjong Factie . .	1 16	109 35
	Pontiana or Lewa, R.en.	0 2N.	109 12
	Point Mampava . .	0 17	108 58
	[illegible]lackoo Road . .	1 4	
	River Sambas, entrance	1 13	109 3
	Tanjong Apee . .	1 55	109 24
	Tanjong Datoo . .	3 00	110 36
	BORNEO Road . .	5 00	114 38
	Pulo Teega . . .	5 38	115 7
	Abai Harbour . .	6 21	116 15
	Keeney Balloo Mountain . . .	6 5	116 40
	Tanjong Sampanmangio, N. P. . .	7 1	116 46
	Point Unasang . .	5 17	119 2
	Point Kanneeoongan .	1 5	119 10
	River Passier, entrance	1 54 S.	116 30
	Ragged Point . .	2 10	116 48
	Shoal Point . .	2 35	116 47
	Point Salatan, S. P. .	4 10	114 42
	—		
	Point Layk, S. W. P. .	5 37	119 33
	MACASSAR Town .	5 9	119 36
	Cape Mandhar . .	3 35	119 9

		Lat. D. M.	Long. D. M.
Celebes.	Cape William . .	2 34 S.	118 58E.
	Cape Temoel or Samsa, S. P. . . .	0 8	
	— N. W. P. . .	0 1N.	119 26
	Cape Donda . .	0 48	119 57
	Cape Rivers . .	1 15	120 34
	Manado . . .	1 28	125 4
	Cape Coffin . .	1 42	125 24
	I. Banca . . .	1 52	125 24
	Kema Village . .	1 22	125 19
	Castican Bay . .	0 48	125 00
	Goonong Tella River .	0 28	123 15
	Cape Talabo . .	0 48 S.	124 12
	Weywongy Isl. about .	4 3	
	Waxway Island, mid. .	3 34	123 14
	Cambyna I. Peak .	5 21	122 1
	Middle Island . .	5 40	120 28
	Boele-comba Hill .	5 33	120 9
	—		
Straits of Macassar.	Waller's Shoals and Laurel Rocks, limits	4 30 4 37	117 7 117 15
	Noesa Sera Islands .	5 2	117 9
	Noesa Comba . .	5 15	117 9
	Shoal off Noesa Comba	5 26	117 00
	Little Pulo Laut I. mid.	4 51	115 53
	Moresses or Manevessa, Island . . .	4 25	116 3
	Dwaalder Island . .	4 12	116 21
	Royal George Shoal .	4 17	116 30
	Two Brothers . .	4 26	116 32
	Great Pulo Laut, N.E.P	3 21	116 41
	— N. P. . . .	3 11	
	— S. Isl. off the S.E.P.	4 7	
	The Three Alike Islands	3 39	116 54
	Dry Sand Bank . .	3 37	117 48
	Triangle Islands, mid.	3 3	117 53
	Little Paternosters, S.P.	2 50	
	— E. P. . . .	2 10	117 58
	— N. W. P. . .	2 8	117 42
	Pamaroong or Dondrekin I. S. P. . .	0 54	117 36
	Seven Islands . .	0 32	119 43
	—		
	Banguey Peak . .	7 19N.	117 6
	Balambang I. N. Harb.	7 16	116 58
	Balabac I. (Hill) .	7 59	117 00
	Mangsee Islands . .	7 32	117 16
	St. Michael's Islands, (Bangcawang) .	7 48	118 40
	Toob-Bataha Shoal .	9 00	119 37
	Palawan, W. end .	8 24	117 14
	— N. P. . . .	11 30	119 37
	Ragged Island . .	11 15	119 21
	Cagayan Soolo . .	7 00	118 36
	Soolo Island, Town .	6 1	121 12
	Takoot Paboonoowan Shoal . . .	6 15	121 32
	Pangootaran I. . .	6 15	120 40
	Belawn I. E. P. . .	6 00	122 4
	Tapeantana Island, E.P.	6 14	122 8
	Tamook Island . .	6 28	121 56
Soolo Sea.	Mataba Island, S. P. .	6 32	121 50
	Peelas I. N. P. . .	6 41	121 45
	Ballook Ballook . .	6 47	121 50
	Basilan, I. E. P. . .	6 30	122 30
	Santa Cruz I. . .	6 56	[illegible]

		Lat. D. M.	Long. D. M.
	Sangboys or Hare's Lips	6 48N.	121 41E.
	Teynga Island	6 52	121 43
	Catanduanes I. S. P.	13 38	124 16
	C. del Espiritu Santo, N. E. P. Samur I.	12 40	125 38
	St. Bernardino Island	12 46	124 38
	Ticao I. Port St. Jacinto	12 34	123 34
	Manilla	14 36	121 2
	Cavite	14 29	120 55
	Ent. Manilla Bay	14 28	
Luconia.	Point Capones	14 52	120 3
	Two Sisters Islands	15 50	119 47
	Point Boliano	16 27	120 00
	Cape Bajador	18 42	121 00
	Point Cavnaion	18 48	121 14
	Cape Enganno	18 39	122 21
	Mauban	14 8	121 44
	Cape St Ildefonso	15 25	121 46
	Samboongan	6 53	122 14
	Point Balagonan	7 51	122 24
Mindanao.	Suriago village, near N. Point	9 47	125 25
	Cape St. Augustine, S. E. P.	6 4	126 48
	South or Serangi Point	5 39	125 32
	Mindanao	7 10	124 35
	Negros, South Point	9 6	123 3
	— Point Sojoton	9 50	122 32
	Cagayanes Islands, mid.	9 34	121 23
	Panay I. Point Nasog S. P.	10 25	122 6
Panay.	— Asloman village	10 32	122 6
	— Point Potob or N. P.	11 48	122 2
	Dry Sand Bank	11 24	121 54
	Sombrero Rock	10 45	121 37
	White Rock	10 28	121 21
	Cuyos Islands		
	— Quiniluban (Northern Island)	11 28	121 11
	— Grand Cuyo	10 52	121 21
	— Southern I.	10 40	121 31
	Caravos or Buffalos	11 53	121 48
	Betsey's Bank, 5 fathoms	11 42	120 57
	Ylin Islands, S. P. off S. P. Mindoro	12 9	121 15
	Coral Shoal, West of ditto, about	12 11	120 57
	Apo Bank, S. P.	12 36	120 33
	— E. P.	12 40	120 36
Apo Bank.	— N. P.	12 45	120 31
	— S. W. P. (Islet)	12 40	120 29
	— West, or Great Islet	12 39	120 28
	— Discovery Bank	12 40	120 43
	Coron Island	11 46	120 12
	Green Island	12 3	119 40
	Haycock	12 9	119 51
	Pinnacle Rock	12 18	119 54
	N. W. Rock	12 23	119 55
	Sail Rock	12 22	119 56
	Busvagnon I. N. P.	12 19	119 56
	Calavite or High I.	12 21	119 56

		Lat. M. D	Long. D. M.
	Group of Islands, S. P.	12 8N.	120 23E.
	N. P.	12 17	
	Turret Island	12 22	120 10
	North Rock	12 27	120 4
Mindoro.	Mindoro I. S. P.	12 11	121 22
	— Point Dongan or Pandan	12 48	120 58
	— Point Calavite	13 27	120 20
	Luban	13 44	120 12
	Goat Island	13 51	120 7
	Babuyan Islands		
	— Lapurip or Dalupiri I.	19 15	121 34
	— Fuga or New Babuyan I.	19 1	121 43
	— Camiguin I.	19 4	122 12
	Babuyan Islands,		
	— Guinapac Rocks	19 5	122 25
	— Didicas Rocks	19 12	122 31
	— Claro (or Old) Babuyan	19 37	122 17
	— Calayan I.	19 28	121 46
	Bashee Islands		
	— Balintang or Richmond Isles	19 58	122 24
	— Sabtang I.	20 14	122 12
	— Bashee I.	20 14	122 9
Bashee Islands.	— Goat I.	20 15	122 7
	— Batan or Monmouth I. S. P.	20 17	122 15
	— ditto Mount, N. P.	20 23	122 21
	— Grafton or High Round I.	20 34	122 13
	— Bayat or Orange I.	20 37	122 7
	North Bashee, High I.	21 3	122 8
	— Northernmost I.	21 9	122 8
	Gadd's Reef	21 43	121 43
	Cumbrian's Reef, doubtful, probably the same as Gadd's Reef	21 35	121 45
	Little Botel Tobago Xima	21 56	121 45
	Botel Tobago Xima	21 59	121 43
	Vele-rete Rocks	21 42	120 58
	Formosa I. South Cape	21 54	121 00
	Gomano Island	1 56S.	127 38
	Lissamatula I. S. E. P.	1 46	126 32
	Xulla Bessey, S. E. P.	2 28	125 58
	— N. E. P.	1 58	
Xulla Besseys.	— N. W. P.	1 58	125 48
	Xulla Mangola, W. end	1 43	125 21
	Greyhound Straits	1 40 1 56	124 30
	Haycock I. off S. W. P. Xulla Talaybo	1 58	124 36
	Skelton's Island, on N. W. P. ditto	1 45	124 36
	Middle Island	1 45	124 28
	Albion's Island	1 53	124 19
	Bouro Island, N. W. P.	3 6	125 57
	— N. ext.	3 2	
	— N. E. P.	3 15	127 5
	— Cajeli or Bouro Bay	3 24	127 4
	— South Point	3 49	
	Amblaw Island	3 52	127 14

		Lat. D. M.	Long. D. M.
	Manipa Island	3 17S.	127 28E.
	Bonoa I. about	3 00	127 56
	Ceram I. Seeal or S.W.P.	3 31	127 56
Ceram.	— Kessing or E. P.	3 55	131 10
	— Waroo Bay	3 25	130 40
	— Old Lamata or Flat Point	2 53	129 42
	— Sawa Bay	2 51	129 6
	Leeuwarden Island	3 20	130 58
	— Shoal	2 56	130 43
Banda Sea.	Goram I.	4 00	131 44
	Matlabella Islands	4 21	131 52
	AMBOINA I. Fort Victoria	3 40	128 15
	Noesa Laut I.	3 40	128 52
	Banda Island, anchorage	4 31	130 00
	Lookisong or Landscape I. S. P.	1 46	128 10
	Pulo Gasses, S. P.	1 41	128 20
	Kekik	1 33	128 37
	Pulo Pisang	1 23	128 53
	Horsburg's Rocks	1 8	128 20
	Boo Islands	1 12	129 18
	Weeda Islands	0 40	128 25
	Kanary Islands, Grand C	1 44	129 42
	— Efbe Harbour	2 12	
	Pulo Popo, S. E. P.	1 12	129 52
	Battanta I. Cape Cambo, W. P.	0 56	130 25
	Fisher's Island	0 56	130 23
	Waygecooe I. S. E. P. or Point Pigot	0 21	131 18
	— Offak Harbour	0 00	130 50
	— Boni Road	0 00	131 12
	Amsterdam I.	0 19	132 15
	Fow or Faux Island	0 6	129 28
	Gagy I. about	0 25	130 3
	Geby I. N. W. end	0 4N.	129 19
	Syang I.	0 22	129 55
	Eye Island	0 24	129 53
	Islet E. of Pulo Moar	0 9	128 58
	Catharine's Islands	0 39	129 11
	Canton Packet Shoal	0 35	128 55
	Ormsbee's Shoal	0 46	
	Ditto soundings 15 fath.	0 42	130 3
	Yowl or Aiou Islands		
	— Aiou, the largest Isle	0 25	131 00
	— N. W. Island	0 38	131 8
	— N. E. Island	0 36	131 15
	— Reef North part	0 41	
	Asia's Islands, S.W. Isle	1 00	131 17
	— N. E. Island	1 4	131 23
	Gillolo I. N. end	2 23	
	— Ossa Village	0 45	128 22
	— Maba Village	0 53	
	— Islet near Pulo Moar	0 9	128 58
	— Point ent. Straits Patientia	0 13S.	127 45
	— Cocoanut Pt. or S. P.	0 45	
Moluccas.	Batchian I. S. E. P.	0 48	128 3
	Amsterdam Island	0 20	127 53
	Kayo or Cayo I. S. P.	0 1	127 23
	— N. P.	0 7N.	
	Negory Kalam, N. P.	0 28	127 37
	Wolf Rock	0 30	127 6
	Tidore Island, S. ext.	0 34	127 24
	Tidore Mountain	0 40N.	127 22E.
	— N. E. end	0 46	127 34
	Ternate Island	0 49	127 30
	Tyfore Island	0 58	126 27
	Meyo Island	1 22	126 39
	Morty or Mortay I. (N. Cape)	2 44	128 25
	Banca Island, Peak	1 52	125 24
	Tagalondo	2 23	125 36
	Bejaren Island, Peak	2 6	125 34
	Siao I. S. Point	2 40	125 35
	— Peak	2 43	125 35
	Sangir Island, S. end	3 21	125 46
	— Watering place on W. side	3 28	125 44
	— N. end	3 46	125 38
	Glatton's Rock	3 50	125 56
	Sallibobo or Toulor Isls.		
	— Kabruang S. P.	3 47	126 55
	— Tulour or Karkalang N. P.	4 25	126 44
	Meangis or Menangus I.	5 00	127 17
	Serangi Islands, S. P.	5 20	125 35
	— Peak on W. Isl.		125 32
	— N. P.	5 31	125 43

XLVI. *From CANTON to KAMTSKATKA, with the adjacent Islands and Shoals.*

		Lat. D. M.	Long. D. M.
	CANTON	23 7N.	113 14E.
	Mir's Bay	22 27	114 30
	Single Island or Chueng Chow	22 25	114 40
	Mendoza's Island	22 31	114 51
	Fokoi Point	22 33	114 53
	Pedro Branco	22 19	115 8
	Point Shalong-Tow	22 39	115 35
China.	Point Tengmee	22 45	115 50
	Point Cup-chee-san	22 49	116 7
	A Black conical mount	22 52	116 11
	Breaker Point	22 57	116 31
	Cape of Good Hope	23 14	116 50
	Small round Island	23 26	116 50
	Lamo or Namo I. W. P.	23 28	117 00
	— N. E. P.	23 32	117 13
	Lamock Island, S. west	23 17	117 21
	The Brothers, southern	23 32	117 48
	Chapel Island	24 11	118 20
	Amoy Harbour	24 20	118 16
	Chin-Chew Bay	24 54	118 40
	Lamyet Islands, south	24 59	119 34
	Ting-hoy harbour	26 10	119 57
	Heysan or Black Islands	28 53	
	Quesan Is. S. eastern	29 22	121 52
	Chusan I.	30 26	121 42
	Nankin	32 5	119 00
	Tchin-san Islands	30 20	122 36
	Shang-Tung Promontory, S. P.	37 00	122 41
	— N. P.	37 25	122 45
	Cape Zeu-ou-Tau	37 36	121 28
	Ten-choo-Foo City	37 48	120 32
	Tchoo-san Island	38 1	121 1
	Keusen Is. northern	38 8	120 44

		Lat.		Long.	
		D.	M.	D.	M.
	Pekin River, anchorage at Peiho . . .	38	59N.	118	00E.
	High Peaked Island, S. W. ext. Corea .	34	5	125	15
	Cape Clouard . .	36	5	129	42
	Sanpon . . .	37	44	128	55
	Ternai Bay . .	45	13	137	29
	Suffren Bay . .	47	51	139	45
Tartary.	Cape Lesseps . .	49	30	141	30
	Castrie's Bay . .	51	29	141	59
	Vanjuas Point . .	52	7	142	42
	Bay de Langle . .	47	49	141	24
	Bay d'Estaing . .	48	59	141	27
	Monneron Island . .	46	20	141	11
	La'Dangereuse Rock .	45	47	142	9
	—				
	Cape Crillon, (ent. Perouse's straits) .	45	54	141	58
	Cape Aniwa . .	46	2	143	30
	Cape Lowenorn . .	46	23	143	40
	Bay Mordwinoff .	46	48	143	14
	Cape Tonyn . .	46	50	143	33
	Point Siniavin . .	47	16	143	00
	Mount Spenberg or Bernizet . . .	47	33	142	20
	Point Muloffsky . .	47	58	142	44
	Cape Alexander Dalrymple . . .	48	21	142	50
	Cape Soinsonoff . .	48	52	143	2
	River Neva, entrance .	49	15	143	2
	Gulf Patience, North P.	49	19		
	Robber Island Reef N. E. P. . . .	48	36	144	33
	— S. W. P. . .	48	28	144	10
	Cape Patience . .	48	52	144	46
	Cape Billinghausen .	49	35	144	26
	Mount Tiara . .	50	3	143	37
Sachalin.	Cape Ratmanoff . .	50	48	143	53
	Cape Croyere . .	51	00	143	43
	Downs Point . .	51	53	143	13
	Shoal	52	30	143	29
	Wurst Point . .	52	57	143	18
	Cape Klokatschef .	53	40	143	7
	Cape Lowenstern .	54	3	143	13
	Cape Elizabeth . .	54	24	142	47
	North Bay . . .	54	16	142	37
	Cape Maria . .	54	17	142	18
	Espenberg Peak . .	54	4	142	50
	Cape Golowgtscheff .	53	30	141	55
	—				
	Cape Romberg . .	53	26	141	45
	Cape Chavaroff . .	53	38	141	26
	Jonas Island . .	56	25	143	16
	Ochotsk . . .	59	20	143	12
	Yamsk . . .	60	46	154	30
	Bolcheretsk . .	52	54	156	42
	Cape Lopatka, Kamtskatka . . .	51	2	156	46
Russia.	St. Peter and St. Paul .	53	00	158	46
	Shipunskey-noss .	53	6	159	50
	Nisjui Kamtskatka .	56	16	162	00
	Cape Tschulkolskoi .	64	13	171	24W
	East Cape . . .	66	6	169	40
	Cape Serdze Kamen .	67	3	171	49
	North Cape . .	68	56	179	9
	—				

		Lat.		Long	
		D.	M.	D.	M.
	Formosa I. S. Cape .	21	54N.	121	00E.
	— N. W. Point .	25	11	121	6
	— N. Point . .	25	18	121	34
	— N. E. Point . .	25	11	121	56
	Lamay Island . .	22	19	120	27
	Pehoe or Pescadore Is.				
	— Southern limit .	23	8		
	— High Island, S. W. limit . . .	23	14	119	26
	— Largest Island .	23	32	119	46
	— Northern limit .	23	56		
	— Bank, S. E. P. .	22	52	119	23
	— ditto, seven fathoms	22	51	119	1
	Pat-chow or Madjicosemah Islands .				
	— Southernmost I. .	24	6	123	52
	— Bluff Point. West ext. Great I. .	24	17	123	45
	— Kumi I. . . .	24	28	123	5
	— Eastern I. Ty-pin-san	24	42	125	36
	— Providence Reef .	25	6	125	11
	Lieu-Chew Islands .				
	—Great Lieu-Chew, S.e.	26	3	128	18
	— ditto, adjacent I. N.P.	27	34		
	— Western Island .	26	20	127	17
	Hoapinsu I. . .	25	44	123	32
	Ty-ao-yu-su I. . .	25	55	123	47
	Sulphur Isls. southern	24	14	141	21
	— middle . . .	24	48	141	12
	— northern . .	25	14	141	10
	Group of four Islands, limits . .	29	30	128	15
		29	40	128	20
	—				
	Pinnacle Islands . .	29	43	130	5
	Ormsbee's Peak . .	29	40	140	20
	A rock . . .	30	45	123	46
	South Island . .	31	30	140	00
	Gotto I. S. end. . .	32	35	128	44
	Asses Ears . .	32	3	128	37
	Quelpaert I. S. P. .	33	8	126	19
	Kiusiu Island .				
	— Cape Tschirikoff .	32	14	131	41
	— Cape Danville .	31	27	131	27
	— Cape Nagaeff .	31	15	131	11
	— Mount Schubert .	31	41	131	12
	— Mount Horner, Peak	31	9	130	28
	— Cape Tschitschagoff S. P. . .	30	57	130	36
	— Cape Tschesma W.P.	31	24	130	2
	— Cape Kagul N. P. .	31	42	130	7
	— Mount Unga, volcano	31	43	130	14
Japan Islands.	— Nangasky harbour ent. . . .	32	44	129	46
	— Cape Nomo S. P. of Bay Nan. .	32	35	129	42
	— Cape Seurote .	32	58	129	35
	Sanao-sima Island N.P.	30	42	131	00
	— S. P. . . .	30	24		
	Tenegasima I. (middle)	30	23	130	30
	Volcano I. . . .	30	43	130	17
	Seriphos I. . .	30	43	130	44
	Apollo I. . . .	30	44	130	24
	Julie I. . . .	30	27	130	13
	St. Claire I. . .	30	45	129	54
	Symplegados Islands N. E. P. . .	31	30	129	42

		Lat. D. M.	Long. D. M.
	Symplegados Islands, S. W. P.	31 26N.	129 37E.
	Meac-Sima I. S. W. P.	31 35	129 40
	— N. E. P.	31 49	129 51
	Nadeshda Rocks	31 42	129 33
	Tsus I. S. end	34 6	129 17
	— Cape Fida-Buengono	34 19	129 30
	— North Point	34 40	129 29
	Colnett's Island	34 16	129 56
	Dagelet I. N. E. P.	37 25	131 22
Japan Islands.	Niphon I.		
	— South Point	33 5	135 55
	— Cape Noto	37 36	137 54
	— A Rock	37 36	137 34
	— Jootsi-Sima	37 51	137 40
	— Jedo	36 29	140 00
	— Cape Kennis	37 10	141 30
	— Zach's Mountain	35 25	132 20
	— Russian's Promontory, S. P.	39 46	139 44
	— N. E. P.	40 00	
	— Town	40 50	140 6
	— Cape Gamally	40 38	139 48
	— Peak Tilesius	40 40	140 11
	— Cape Greig	41 9	140 8
	— Cape Sangar (ent. Straits of Sangar)	41 16	140 14
	Osima Island	41 31	139 19
	Kosima Island	41 21	139 46
	Okosir Island (middle)	42 9	139 30
	Jesso Island		
	Cape Nadeshda (ent. of Straits of Sangar)	41 25	140 9
	— Cape Sineko	41 38	133 53
	— Matzumay town	41 32	140 4
	— Cape Oota-Nizawu	42 18	139 46
	— Cape Kutusoff	42 38	140 1
	— Cape Rayten	42 57	140 16
	— Cape Okamay, S. P.	43 11	140 13
	— Cape Taka-sima	43 21	140 31
	— Mount Rumoffsky	42 50	141 11
	— Cape Malespina	43 42	141 18
	— Cape Schischkoff	44 25	141 32
	— Pallas Mountain	44 00	141 54
	— Cape Romanzoff (N. Point)	45 26	141 34
	— Cape Soya	45 31	141 51
	— Cape Shaep	45 21	142 12
	Peak de Langle, Rioschery I.	45 11	141 12
	Cape Guibert, Reifunschery N. E. P.	45 28	141 4
	Jeurire Island	44 28	141 17
	Janikesseri Island	44 29	141 22
	Staten Island, S.W. end	44 26	147 28
	— Cape Vries, (Vries Straits)	45 26	149 43
	Company's Island		
	— Cape Shouten	46 18	150 58
	— North end	46 28	151 20
	Marikan I. N. end	47 10	153 6
	South end (Bousole Straits)	46 46	152 32
	Sarytscheff I. Peak	48 6	153 12
	Raakok Island	48 8N.	153 15E.
	Mussir Island	48 16	153 15
	Trap Rocks	48 36	153 44
	Charamukatan I. Peak	49 8	154 39
	Poromuschir I. S. P.	50 00	155 24
	— Peak Fuss (S. W.P.)	50 15	155 10
	— East Point	50 28	156 9

XLVII. *NEW HOLLAND and the adjacent Islands and Shoals.*

		Lat. D. M.	Long. D. M.
	Pedro Branco (Rubrick)	44 00S.	147 45E.
	South West Cape	43 34	146 6
	Mew Stone	43 42	146 28
	South Cape	43 38	146 49
	Eddystone	43 51	147 8
	Sidmouth's Rock	43 46	147 9
	Tasman's Head	43 32	147 26
Van Dieman's Land.	D'Entrecasteaux's Port	43 32	147 6
	Adventure Bay	43 21	147 32
	Frederick Henry Bay	42 58	147 42
	Cape Pillar	43 12	148 9
	Oyster Bay	42 42	148 8
	St. Patrick's Head	41 48	148 22
	Cape Portland	40 49	148 15
	Port Dalrymple	41 3	147 11
	Circular Head	40 43	145 15
	Cape Grim, N.W.Prom.	40 41	144 46
	West Cape or Sandy Pt.	41 4	144 36
	Macquarie's Harbour	42 12	145 28
	Point St. Vincent	43 16	145 55
	Port Davey	43 28	146 00
	Ent. to Bank's Straits	40 38	148 20
	Furneaux Islands,		
	— Barren I. S. E. ext.	40 25	148 26
	— Clarke's I. S. ext.	40 34	
	— N. Sister, near N. P. of Great Island	39 38	147 56
	Endeavour Rock	39 38	147 35
	Kent's Group	39 29	147 17
	The Pyramid	39 48	147 13
	Waterhouse Island	40 48	147 32
	Hunter's Islands		
	— Black Pyramid, W.	40 33	144 22
	— Albatross I. N. West	40 25	144 35
	King's Island N. E. P.	39 36	143 55
	West ent. Bass's Straits	39 10	143 30
	Cape Albany Otway	38 53	143 30
	Port Philip, ent.	38 19	144 36
	Western Port	38 31	145 10
	Wilson's Promontory, S. ext.	39 11	146 24
	Ram Head	37 39	149 45
	Cape Howe	37 30	150 7
New South Wales.	Cape Dromedary	36 18	150 9
	Jervis Bay	35 7	150 52
	Red Point	34 29	151 14
	Botany Bay, entr. (C. Banks)	34 00	151 23
	Port Jackson, ent.	33 50	151 25
	Broken Bay	33 34	151 27
	Port Stephens	32 43	152 10

New South Wales.

	Lat. D. M.	Long. D. M.
Cape Hawke	32 13S.	152 30E.
Smoky Cape	30 51	153 7
Solitary Islands	30 9	153 21
	29 56	
Cape Byron	28 7	153 30
Point Danger	28 7	153 30
Shoals off ditto	28 7	153 39
Cape Morton	27 1	153 23
Shoal	26 58	153 28
Sandy Point	24 42	153 17
Cape Capricorn	23 29	151 00
Keppel Bay	23 18	150 36
Barrier Reef, S. P.	22 50	152 36
Cape Townsend	22 12	150 11
Cape Palmerston	21 27	149 00
Cape Hillsborough	21 00	148 33
Cape Conway	20 32	148 30
Cape Gloucester	19 58	148 6
Cape Cleveland	19 10	146 40
Cape Sandwich	18 16	146 8
Cape Grafton	16 51	145 54
Cape Flattery	14 52	145 18
Cape York	10 38	142 33
New Year's Island	10 48	133 18
Vandieman's Cape	11 12	129 54
Red Island, off P. Vulcan	15 9	124 22
Minstrel's Shoal	17 14	118 57
Greyhound Shoal	19 58	114 40
Clarke's Reef N. of Rosemary I.	20 17	
Eastern Rosemary I. N. E. P.	20 26	
Western ditto N. P.	20 35	115 40
Doubtful Shoal	21 37	112 25
Piddington's Islands	21 36	114 56
Shoal (land of N. Holland in sight from the mast head)	20 15	
North West Cape	21 50	114 25
Dirk Hartog's Road, ent. to Shark's Bay	25 6	113 15
Houtman's or Abrohlos Shoals	28 30	113 35
Rottenest Island	31 58	114 24
Cape Leuwen or S. W. Cape	34 22	115 6
Cape Chatham	35 3	116 22
Cape Howe	35 9	117 38
K. George III. Harbour	35 6	118 1
Point Hood	34 23	119 36
Termination Island	34 30	121 58
Endeavour, small Isl.	36 27	127 2
Port Lincoln	34 48	135 45
Nepean Bay	35 44	137 55
Endeavour Shoal, off Cape Jaffa	36 58	139 31

XLVIII. *Islands, Rocks and Shoals in the NORTH PACIFIC OCEAN.*

	Lat. D. M.	Long. D. M.
Aleootskia I.		
— Westermost	52 46N	170 42E.
— Oonalaska	53 54	166 22W
Bank (64 fathoms)	34 22	178 30E.
Rica de Plata	33 50N.	160 39E.
Reef	32 00	147 00
Island	31 30	140 00
Week's Reef 36′ N. E. and S. W.	31 15	153 9
Island	31 00	147 6
Ganges Island	30 45	154 25
Bank of Soundings	30 30	177 30
Island	30 00	137 00
Island	30 00	139 00
Island	30 00	141 30
Island	30 00	143 00
Island	30 00	144 24
Rica de Oro	29 54	157 3
Island	29 40	143 00
Island	29 33	137 00
Island	29 30	143 00
Island	29 00	175 45
Calunas I.	28 55	158 00
ditto (another account)	28 53	162 00
Island	28 30	176 50
Patrocinio Island	27 58	175 44
Disappointment Island	27 18	139 25
St. Juan	27 30	142 48
Bassiosos I.	26 6	173 27
Island	26 6	154 36
Reef	26 6	160 00
Copper Island	26 00	131 48
Tree Island	26 00	145 44
Lasker's Island	26 00	173 24
Island	25 53	131 17
Island	25 42	131 13
Reef	25 30	152 50
Bishop's Rock	25 22	132 00
North Island	25 14	141 14
Island	25 12	131 36
Grampus Island	25 10	146 00
Sulphur Island	24 48	141 20
Kendrick's Rock	24 30	133 36
Marcus Island	24 18	153 42
Weeks Island	24 00	154 00
Dexter's Island	23 24	163 5
Island	23 3	162 57
Reef	22 6	142 28
Jardines	21 35	151 30
Parel or Peru I.	21 10	141 40
Abregoes Shoal	21 1	136 43
Reef	20 42	153 00
Douglas Reef	20 32	136 12
Lamira I.	20 30	166 42
Island	20 30	152 50
Bishop's Rock	20 16	136 53
Week's or Wilson's I.	19 21	166 55
Reef	19 10	165 42
Halcyon I.	19 6	163 33
Folger's I.	18 22	155 15
Reef	17 9	156 13
Tarquin I.	17 00	160 00
Reef	16 36	169 42
Island	16 00	171 42
Pajaros Islet, northern.	20 34	145 48
Urracas, about	20 20	146 15
Assumption Island	19 45	145 35
Almagan Island	18 5	146 21

		Lat. D. M.	Long. D. M.
	Bird Island . .	16 47N	146 13E.
	Tinian . . .	15 00	145 47
	Guam, Umatac Bay .	13 21	144 20
	——		
Radack Islands.	Radack chain of Islands, viz.		
	Aour, circular group of 32 islands extending 13 miles N. W. and S. E. anchorage .	8 19	171 12
	Kaven group 33 miles N. W. and S. E.		
	— Araksheef Island, (largest I.) . .	8 54	170 49
	— Southern Island .	8 29	171 11
	Tchitchagoff, circular group of Islands N.W. & S.E. 24 miles, middle	9 6	170 4
	Romanzoff, circular group of 65 islands, E. & W. 30 miles. & 10 miles wide inclosing a sea 12 miles wide & 27 miles long . .		
	— Odia I. eastern; anchorage . .	9 28	170 16
	Legiep or Hayden group	9 51	169 13
	Ailou group, 15 miles long, 5 miles wide		
	— Krusenstern-Capenius I. (northern) .	10 27	170 00
	I. Du Nouvel An . .	10 8	170 55
	KutosoffOrUdirickgroup separated by a channel from a southern group called Souvoroff or Tagay, extending N. & S. 25 miles		
	— Channel . .	11 11	169 50
	Group north of Kutosoff		
	— Mille	6 16	
	— Medjuro . . .	7 15	
	— Arno	7 25	
	Bigar, south of Kutosoff	11 40	
	——		
	Pescadores Is. southern	11 00	167 30
	——— northern	11 20	167 2
	——		
	Ralick chain of Islands, extend nearly N. & S. about one degree west of the Radack chain, viz.		
Ralick Islands.	Ebon group . .	5 50	167 15
	— Noamureck I. .	6 30	
	Kuli group . . .	6 40	
	Helut group . .	7 30	
	Odia group . . .	8 15	
	Namou group . .	9 00	
	— Litel Island . .	8 55	
	— Tebot Island . .	8 30	
	Quadelon group . .	9 20	
	Oudia-Milai group .	10 45	
	Radogala group . .	11 00	
	Bigini. (northern) .	11 20	167 15

		Lat. D. M.	Long. D. M.
	Johannes . . .	6 55N.	132 30E.
	Lion's Island . .	5 16	132 13
	St. Andrew's Island .	5 20	132 16
	Pulo Anna . . .	4 38	132 3
	Pulo Mariere . .	4 19	132 28
	Lord North's I. . .	3 3	131 20
	Ganges Shoal, S. W. P.	2 52	131 7
	— N. E. P. . .	3 6	131 23
	Helen's Shoal . .	2 50	131 41
	Freewill or St. David's Islands, limits .	0 49 1 2	134 17 134 30
	——		
New Phillipine or Caroline Islands.	Pelew Islands,		
	— Baubelthouap, E. P.	7 41	134 55
	— Northernmost, Kyangle . .	8 8	134 50
	— Large Reef, part dry	8 18	134 41
	— Southernmost, Angour . . .	6 53	134 21
	Matelotes, N. E. I. .	8 34	137 45
	— Southernmost .	8 19	137 45
	Yap or Hunter's I.N.P.	9 40	
	— S. P. . . .	9 30	138 8
	Philip Islands . .	8 6	140 3
	Thirteen Islands .	7 18	144 21
	Haweis' Island . .	7 30	146 28
	Strong's Island . .	5 12	162 58
	Islands . . .	5 28	153 24
	Islands . . .	5 47	157 42
	Islands . . .	6 9	160 51
	Islands . . .	6 17	159 12
	Hope's Islands . .	5 15	165 12
	Baring's Islands . .	5 35	168 13
	Palmyra Island . .	5 49	162 29
	Cluster of Islands .	9 38	161 26
	Ditto . . .	9 55	
	Brown's Range . .		
	— Arthur's Island, N. .	11 43	162 42
	— Parry's Island, S. .	11 19	162 52
	Margaret's Island .	8 52	166 15
	Lydia's Island . .	9 4	165 58
	Catharine's Island .	9 14	166 2
	Arrecife's Island .	9 36	161 8
	Muskitto Group, low and dangerous .	7 20 7 47	168 23
	Peterson's Island . .	8 54	166 35
	Chatham Island . .	9 20	171 20
	Reef	10 00	179 21
	Calvert's Islands .	8 48	172 00
	Ibbetson's Islands .	8 6	172 8
	Elmore Islands . .	7 42	168 45
	Mulgrave's Islands .	5 54	172 39
	Banham's Island . .	5 50	169 48
	Cook's Island . .	1 18	171 57
	Hall's Island . .	0 54	173 4
	Reef	1 00	179 34
	Pitt's Island . .	2 54	174 30
	Matthew's Island .	1 50	175 10
	Simpson's Island .	0 26	175 27
	Macasgill's Islands .	6 12	160 53
	St. Bartholomew .	15 10	163 48
	Cornwallis or Smyth's Isles . . .	16 46	169 29
	Wake's Island . .	19 00	166 46
	Lamira, W. Pt. . .	20 24	166 42

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Gasper Island . .	15	3N.	177	00E.
	Gasper Rico I. . .	14	42	169	3
	Wake's Rocks . .	17	48	173	45
	St. Peter . . .	11	3	178	55W
	Barbados . . .	8	54	178	21
	Krusenstern's Rock .	22	15	175	37
	Necker Island . .	23	34	164	32
	French Frigate's Shoal	23	45	165	50
	Lisiansky's Island .	26	3	173	40
	—				
Sandwich Islands.	Owhyhee, N. point .	20	17	155	58
	— E. point . .	19	34	154	54
	— S. point . . .	18	54	155	45
	— Karakakoa Bay .	19	28	155	56
	Mowee, E. point . .	20	50	155	56
	— S. Point . .	20	34	156	12
	— W. point . .	20	54	156	36
	Tahoorowa . .	20	35	156	33
	Ranai, S. point . .	20	46	156	52
	Morotoi, W. point .	21	10	157	14
	Woahoo . . .	21	43	157	58
	Attoi, Whymoa Bay .	21	57	159	40
	Tahoora . . .	21	40	160	24
	Oneeheow . . .	21	50	160	15
	Oreehoua . . .	22	2	160	8
	Bird's Island . .	23	8	161	45
	Gardner's Island, discovered 1820 . .	25	3	167	40
	Maro's Reef, ditto .	25	28	170	20
	—				
	Gallego Island . .	1	42	104	5
	Christmas or Noel I. .	1	58	157	32
	Sidney or Fanning's I.	3	44	159	22
	Island	4	30	126	00
	New-York Island .	4	44	160	6
	Cocoss Islands, or Chatham Bay . .	5	27	87	15
	Palmyra I. . . .	5	48	162	19
	Island . . .	6	36	166	50
	Barber's Island . .	8	50	178	00
	Reef	10	00	179	24
	Clipperton's low Island	10	28	109	19
	A Rock . . .	11	6	154	30
	Island . . .	11	33	164	00
	Island . . .	13	9	168	24
	Shoal	13	32	170	31
	Shoal . . .	14	30	170	33
	Cluster of Islands . {	16	00	133	00
		17	00	136	00
	Island . . .	16	30	163	54
	Passion Rock . .	16	56	109	5
	Cornwallis I. . .	16	54	169	33
	New Blada . .	18	17	114	3
	Clarion Island . .	18	21	114	52
	Island . . .	18	22	155	15
	Shoal . . .	18	27	170	30
	Socora Island . .	18	48	110	10
	Island . . .	19	15	166	32
	St. Berto . . .	19	18	109	53
	Island . . .	19	22	115	15
	Roca Partida . .	19	4	111	6
	Mallon Island . .	19	23	165	23
	Cloud's Island . .	19	46	115	00
	Copper Island . .	20	6	131	54
	Island . . .	21	00	176	34
	Shaler's Island . .	22	6	112	14

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Massachusetts Island .	22	28N.	177	5W
	Island . . .	24	4	168	00
	Henderson Island	24	6	128	30
	— another account .	24	26		
	Gardner's Reef . .	24	11	168	9
	Pollard's Island . .	24	48	168	00
	Allen's Reef . .	25	00	167	57
	Cooper's Island . .	25	4	131	26
	Maro's Reef . .	25	26	170	16
	Island . . .	25	22	131	26
	A Rock . . .	25	30	174	3
	Laysan's Island . .	25	50	171	51
	Liscanskey's Island .	25	52	173	41
	Neva Island . .	26	5	172	25
	Maro's Reef, (dangerous)	26	6	170	24
	Island & Rock . .	26	24	170	54
	Pearl& Kermes group or	27	46	176	15
	Clarke's Reef 60 miles N. W. and S. E. .	27	48	176	6
	Bunker's Island . .	28	00	173	30
	Island . . .	28	25	178	14
	Island . . .	28	54	178	45
	Swift's Island . .	32	53	119	6
	—				
	Culpepper's Island .	1	40	92	00
	Wenman's Island .	1	23	91	44
	Redondo Rock . .	0	15	91	34
Gallepagos Islands.	Abington Island, C. Ibetson . . .	0	29	90	43
	Albemarle I. C Berkeley	0	2	91	31
	— Christopher's Point	0	50S.	91	25
	James I. Harbour .	0	12	90	41
	Charles I. S. P. . .	1	30	90	33
	Chatham I. N. E. P. .	0	45	89	9
	— Stephen's Bay .	0	53	89	37

XLIX. *Islands, Rocks and Shoals, in the*
SOUTH PACIFIC OCEAN.

		Lat. D.	Lat. M.	Long. D.	Long. M.
	New Guinea . .				
	— Middleburg Island	0	20S.	132	16E.
	— Cape of Good Hope	0	20	132	31
	— Flat Point . .	0	46	134	25
	— Cape Valshe . .	8	26	137	28
	— Cape Rodney . .	10	2	147	58
	— King William's Cape	6	40	143	31
	Torres or Endeavour Straits . . .				
	EasternFields or Reefs, N. E. end . .	10	2	145	43
	— N. W. part . .	9	59	145	26
	Murray's Islands . .	9	53	144	3
	Wamvax or Darnley I.	9	28	143	40
Torres Straits.	Pandora's Shoals, N. P.	9	55	144	14
	— Wreck Reef, S. P.	11	25	144	00
	— Portlock's Reef .	9	48	144	45
	— ent. Torres Straits .	9	54	144	42
	— Boot Reef . .	9	59	144	40
	Indefatigable's ent. ditto	11	50	144	10
	Halfway Island . .	10	7	143	19
	Booby Isle . . .	10	27	141	56
	York I. (Mt. Adolphus)	10	37	142	40

Solomon Islands.

	Lat. D.	M.	Long. D.	M.
Prince of Wales' group, N. P. .	10	00S.	142	12E.
Kangaroo coral reef	13	22	143	47
Providence Islands				
— Little Providence or Danger I. . .	0	11	135	12
— N. W. ext. of Shoal off ditto . .	0	1	135	8
Louisiade Isles . .				
— Cape Deliverance .	11	42	154	30
Stephen's Island . .	0	21	137	48
Durour's Island . .	1	17	143	30
Admiralty Islands, limits . . {	1	50	146	00
	3	10	148	6
Sydney Shoal . .	3	20	146	50
Active's first Reef (discovered 1811) . .	3	40	146	53
— second reef (ditto)	3	41	146	37
New Ireland . .				
— Cape St. George .	4	54	152	59
— Carteret's Harb. .	4	48	152	46
New Hanover W. end	2	25	149	6
New Britain . .				
— Cape Palliser . .	4	18	152	10
— Cape Orford . .	5	40	152	21
— Port Montague .	6	12	151	2
— Cape Ann . .	6	27	149	33
Cocos Islands . .	4	30	156	36
Shoals W. of Bouganville's Strait .	6	11	154	22
Bouganville Strait .	7	00	155	55
Laughlan's Islands, S E. ext. . . .	9	20	153	42
Bridgewater Shoal .	8	54	156	49
Cape Deception . .	8	30	156	56
Cape Nepean . .	8	51	157	32
Cape Marsh . .	9	7	158	46
Deliverance small Isld's	10	51	162	27
Indispensable Strait, S. ent. . . .	10	15	161	15
Bellona Island . .	11	6	159	37
Bellona Shoal . .	12	5	159	48
Pandora and Indispensable Shoal, N. P. .	12	9	160	30
— S. P. . . .	12	46	160	45
Well's Shoal . .	12	20	157	58
Port Praslin . .	7	30	157	51
Stewart's Island . .	8	24	163	00
Bradley's Shoal . .	6	45	161	00
Lord Howe's Group .	5	24	159	37
Hunter's Islands . .	4	48	157	00
Shank's Island . .	0	28	163	00
Blaney's Island . .	0	39	174	15
Dundas Island . .	0	15	173	58
Drummond's Island .	1	12	176	24
Byron's Island . .	1	11	177	13
Hope Island . .	2	47	176	59
St. Augustine Island .	5	36	176	15
Sherson's Island . .	5	56	176	33
Ellice's Group . .	8	29	179	6
Mitchell's Group .	9	6	179	48
Plaskett's I. . .	9	18	179	50
Independence I. . .	10	25	179	00
Mitchell I. . .	10	27	179	22
Island . . .	10	45	179	35

New Hebrides.

	La. D.	M.	Long. D	M.
Onaseuse or Hunter's I.	15	31S.	176	11E.
De Peyster's Islands .	8	5	178	17
Ocean's High Island .	0	48	170	49
Pleasant Island . .	0	20	167	10
Gardner's Island . .	1	00	168	40
Duff's Group . .	10	00	166	50
Ganges' Island . .	9	44	166	43
Stewart's Island . .	8	24	163	00
Egmont or SantaCruzI.				
— Cape Boscawen .	10	55	166	10
Pitt's or Alderney I. .	11	50	166	46
Cherry Island . .	11	37	170	24
Volcano Island . .	10	39	166	12
Mitre Island . .	11	49	170	42
Barwell Island . .	12	13	169	00
Pandora's Reef . .	12	11	172	00
Charlotte Bank .	11	45	174	42
—				
Sir J. Banks's Island .	13	27	167	24
Espiritu Santo, C. Lisburne . . .	15	41	166	57
— C. Cumberland .	14	39	166	47
— Bay St. Philip and St. James . .	15	10	167	5
— C. Quiros . .	14	56	167	20
Leper's Island . .	15	23	167	58
Maskelyne's Island .	16	32	167	59
Mallicolo, C. Sandwich	16	28	167	59
— Port Sandwich .	16	25	167	53
St. Bartholemew's I. .	15	42	167	17
Aurora Island . .	15	8	168	17
Table Island . .	15	38	167	7
Whitsuntide Island .	15	44	168	20
Ambrym Island . .	16	9	168	13
Paoom Island . .	16	30	168	29
Three Hills . .	16	59	168	22
Apae Island . .	16	46	168	22
Sheppard's Islands .	16	58	168	42
Monument . . .	17	14	168	38
Montague Island .	17	26	168	32
Hinchinbroke Island .	17	25	168	38
Sandwich Island .	17	41	168	33
Erromango, Traitor's Head . . .	18	43	169	20
Immer Island . .	19	16	169	46
Tanna, Port Resolution	19	32	169	41
Erronam . . .	19	39	170	15
Enatum . . .	20	10	170	4
Durand's Reef . .	22	6	169	2
Walpole I. . . .	22	39	169	16
Matthew's or Hunter's Island . , .	22	24	172	15
—				
Diana's Bank, about .	15	41	150	30
Bougainville's Reefs {	15	35	148	00
	15	12	147	51
Alert's Reef . .	17	2	151	49
Mellishe's Keys and Reefs . . .	17	16	156	12
Bampton Shoal, limits . . {	18	49	158	2
	19	30	158	45
Avon's I. . .	19	30	158	12
Chesterfield Bank .	19	53	158	25
Bellona Shoals . .	20	55	159	47
Booby Shoal . .	21	2	159	2

TABLE XLVI. Latitudes and Longitudes.

	Lat. D.	Lat. M.	Long. D.	Long. M.
Minerva's Shoal .	20	50S.	159	23E.
	21	22	159	10
Baring's Shoals .	20	40	158	15
	20	50	159	30
— Sandy I. . .	21	24	158	30
Keen's Reef . .	21	9	155	49
Mid-day Reef . .	21	58	154	20
——				
Small low woody Island	18	3	162	51
Moulin Island . .	18	31	162	52
Reef, about . .	19	00	162	52
N. W. Point . .	19	58	165	30
Balleabea Island. .	20	7	164	22
Pudyona, N. W. P. .	20	6	164	7
Cape Colnet . .	20	30	164	56
Cape Coronation .	22	5	167	8
Queen Charlotte's Foreland . . .	22	15	167	13
Isle of Pines . .	22	42	167	34
Botany Island . .	22	27	167	17
Prince of Wales Foreland, S. P. . .	22	30	166	50
Port St. Vincent . .	22	00	165	55
Loyalty Island . .	20	54	166	30
——				
Wreck Reef and Sand Bank . . .	22	11	155	19
Cato's Bank . .	23	6	155	23
Reef . . .	23	40	160	14
Reef . . .	23	48	161	14
Ray's Island . .	25	00	166	21
Reef . .	26	4	160	00
	26	12		
Sir C. Middleton's Is.	28	13	160	31
Middleton's Shoals .	29	14	158	53
Elizabeth Reef . .	30	5	159	00
Island . . .	31	14	160	37
Lord Howe's I. . .	31	26	159	00
Norfolk I. (Mt. Pitt) .	29	2	168	10
Rosavetta Reef . .	30	30	173	28
——				
North Cape . .	34	27	173	4
Cape Bren . .	35	10	175	00
Cape Colville . .	36	24	175	48
Mercury Bay . .	36	48	176	6
Cape East . .	37	44	178	58
Tolaga Bay . .	38	22	178	35
Table Cape . .	39	6	178	2
Cape Kidnappers .	39	43	177	16
Cape Turnagain .	40	32	176	49
Banks' I. E. end .	43	43	173	00
Cape Saunders . .	45	37	170	16
Molineaux Harbour .	46	8	169	41
The Snares . .	48	6	166	20
Knight's Island . .	48	15	166	41
Cape South . .	47	17	167	16
South West Bay .	46	30	167	25
Solander's Island .	46	28	166	37
West Cape . .	45	50	166	6
Dusky Bay . .	45	40	166	16
Open Bay . .	43	54	168	43
Cape Foulweather .	41	58	171	30
Cape Farewell . .	40	40	173	18
Queen Charlotte's Sound	41	5	171	40
Cape Campbell . .	41	34	174	56
Cape Paliser . .	41	24	175	41
Cape Egmont . .	39	23	174	12
[illegible] Island . .	38	5	175	5

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Macquarie's Island .	54	42S.	159	45E.
	The Judge and his clerk	54	10	160	7
	The Bishop & his clerk	55	11	159	57
	Auckland's Group .	50	44	166	00
	Campbell's Island .	52	32	169	30
	Bounty Islands . .	47	32	179	2
	Antipodes Island .	49	35	179	2
	Chatham Island. C. Young . . .	43	48	176	58W
	Cornwallis Islands .	44	36	175	27
	Macauley Island .	30	8	179	00
	Sunday Island . .	29	12	178	13
	Vasques . . .	25	40	174	56
	Nicholson's Shoals	23	59	178	20
		23	37	177	52
		20	6	168	36
	——				
	Rotumah or Grenville's Island . . .	12	29	176	57E.
	Solitary Island . .	10	40	176	00W
	D. of Clarence's I. .	9	9	171	31
	D. of York's I. .	8	33	172	4
	Quiros Island . .	10	40	170	00
	Jesus Island . .	6	46	166	00
	Letticus I. . .	11	48	162	00
	Suwarrow's Islands	13	6	163	23
		13	15	163	31
	Wallis Island . .	13	22	176	16
	Proby's Island . .	15	53	175	51
	Gardner's Island .	17	57	175	17
	Keppel's Island . .	15	53	174	12
	Boscawen's Island .	15	50	174	8
	Navigator's Islands,				
	— Opoun, E. P. .	14	9	169	2
	— Leone, S. P. .	14	8	169	16
	— Tanfoue, E. P. .	14	5	169	18
	— Maoune, E. P. .	14	17	170	3
	— Oyolava, E. P. .	14	3	171	7
	— Otatuelah . .	14	30	170	41
	Calinasse, N. P. .	13	45	171	51
	Islot Plat . . .	13	51	171	48
Friendly Islands.	Amargura . .	18	00	174	30
	Vavaoo (Howe's) Is.	18	50	174	00
	Lati or Bickerton I. .	18	52	174	42
	Savage Island . .	19	2	169	50
	Toofoa . . .	19	46	175	6
	Haanho . . .	19	41	174	15
	Bouhee . . .	19	34	174	29
	Annamoka . .	20	14	174	50
	Hoonga-hapee . .	20	36	175	17
	Tongataboo,				
	— Van Dieman's Road	21	6	175	5
	Eoaa, E. P. . .	21	24	174	45
	Pylstaart's Island .	22	22	175	41
	——				
	Pearl & Herme's Reef	27	46	176	00
	King George's Reef .	19	56	167	30
	Palmerston Island .	18	00	162	57
	Whytootacke . .	18	56	159	45
Society Islands.	Hervey's Island . .	19	17	158	48
	Wateoo Island . .	20	1	158	15
	Maria I. . . .	21	45	155	10
	Mangeea Island .	21	57	158	7
	Roxburgh Islands .	21	36	159	40
	——				
	Scilly Island . .	16	30	155	10
	Lord Howe's I. . .	16	16	154	6
	Maurura Island . .	16	26	152	33

		Lat. D.	Lat. M.	Long. D.	Long. M.
Society Islands.	Bolabola Island . .	16	32S.	151	52W
	Ulietea . . .	16	45	151	31
	— Ohamaneno harb. .	16	45	151	35
	Huaheine, Owharre Bay	16	43	151	8
	Sir C. Sander's I.	17	25	150	58
	Eimeo (Taloo harbour)	17	30	150	00
	Tethuroa . . .	17	1	149	36
	Otaheite, Point Venus	17	29	149	36
	— Oaitipeha Bay .	17	46	149	14
	Osnaburg or Miatea .	17	52	148	6
	——				
Dangerous Archipelago.	Pr. of Wales I. N. P.	14	58	147	50
	Palliser's Island . .	15	38	146	30
	Chain Island . .	17	25	145	30
	Gloucester Island .	20	31	145	54
	Ohetiroa . . .	22	27	150	49
	Remitura I. . .	22	43	152	00
	Toobouai . . .	23	25	149	20
	High Island . .	23	42	148	3
	Byron's Islands . .				
	— Taoukaa Island .	14	30	145	9
	Disappointment Islands	14	7	141	22
	Adventure Island .	17	7	144	22
	Furneaux Island .	17	11	143	7
	Resolution Island .	17	23	141	45
	Island . . .	16	00	139	00
	Island . . .	17	00	138	00
	Bird Island . .	17	49	142	43
	Bow Island . .	18	17	140	43
	Pr. Henry's Island .	19	00	141	22
	Cumberland I. . .	19	18	140	52
	Gloucester Island .	19	11	140	20
	Queen Charlotte's I. .	19	18	138	20
	Whitsunday Island .	19	26	138	12
	Lagoon Island . .	18	48	138	33
	——				
	Osnaburg Island .	22	8	140	37
	Bligh's Lagoon, I. .	21	43	140	30
	Carysfoot Island .	20	49	138	33
	Lord Hood's Island .	21	31	135	32
	Gambier's Island .	22	55	135	00
	Crescent Island . .	23	12	134	32
	St. Juan Baptista .	24	26	135	6
	Pitcairn's Island .	25	4	130	25
	Oparo Island . .	27	36	144	11
	——				
Washington Islands.	Nukahiwa I. (Federal)				
	— Port Tochitschagoff	8	57	139	42
	— Port AnnaMaria, ent.	8	57	139	40
	— Cape Martin S. E.P.	8	57	139	32
	— South Point . .	8	59	139	44
	— N. W. point .	8	53	139	49
	Uahuga I. (Washington I.) W. P. .	8	58	139	13
	Uapoa I. (Adams) .	9	21	139	39
	Level I. (Lincoln) .	9	29		
	Mottauity Islands (Franklin) .	8	37	140	20
	Hiau I. (Knox. Roberts)	7	59	140	13
	Small Sandy Island .	7	57	140	3
	Fattuuhu I. (Hancock)	7	50	140	6
	——				
Marquesas.	Hood's Island . .	9	26	138	52
	Ohevahoa . .	9	41	139	2
	Ohitahoo, Resolution Bay .	9	55	139	9

		Lat. D.	Lat. M.	Long. D.	Long. M.
	Onateaya Island .	9	58S.	138	51W
	Magdalena Island .	10	25	138	49
	——				
	Bunker's Shoal . .	0	17	160	40
	Marcus Island . .	0	26	159	50
	Island . . .	1	5	138	54
	Brock's Island . .	1	13	159	30
	Island . . .	3	32	173	45
	Hero Island . .	5	40	155	55
	Island . . .	6	39	166	18
	A Rock . . .	7	51	139	54
	Pennryhn's Island .	9	1	157	35
	Tienhoven I. . .	10	5	156	57
	Groningue I. . .	10	5	156	50
	Reirsen's Island .	10	11	160	49
	Humphrey's I. . .	10	27	160	55
	A Reef . . .	10	46	166	6
	Pescado I. . .	10	33	159	25
	Roggewien's I. . .	10	51	156	7
	Tiburones I. . .	10	58	143	00
	Flint Island . .	11	28	152	6
	Bauman's Islands .	11	52	155	12
	Spiridoff Island .	14	41	144	59
	— Perhaps Isl. Oura	14	37	146	10
	Isle de Chiens . .	14	50	138	47
	Isle Romanzoff . .	14	57	144	28
	Isles de Krusenstern extending N. N. E. and S. S. W. 15 miles } centre	15	00	148	41
	Chaine du Rurick, N. E. P. . . .	15	11		
	— E. P . . .	15	20	146	30
	— W. P. . . .	15	20		
	Dageraad Island .	15	45	146	56
	Dean, or Prince of Wales, or Oanna Island } W.P.	15	00	148	22
	E. P.	15	16	147	12
	Island . . .	16	00	139	00
	Island . . .	17	00	138	00
	Island . . .	20	00	167	50
	Elizabeth Island .	21	6	178	36
	Eunice Island . .	21	8	178	47
	Armstrong's Island .	21	21	161	4
	Anderson's Island (or Elizabeth I.) . .	24	24	128	11
	Ducie's Island . .	24	40	124	40
	Island . . .	25	13	130	28
	St. Felix Islands N. P.	26	20	79	47
	— W. P. . .	26	17	80	4
	Gray's Island . .	26	24	92	24
	Sales y Gomez . .	26	36	105	34
	Easter Island . .	27	8	109	40
	Island . . .	28	6	95	12
	Group of Islands .	31	3	129	24
	Massafuero . .	33	45	80	38
	Juan Fernandez S.W.P.	33	45	79	6
	— E. P. . . .	33	41	78	53
	——				
New South Shetland.	NEW SOUTH SHETLAND.				
	Clarence Island, Floyd's Promontory .	60	57	54	6
	———Cape Bowles	61	20	54	8
	Cornwallis Island .	61	00	54	28

	Lat. D. M.	Long. D. M.
Seal Islands . .	61 00S.	55 32W
Cape Valentine . .	61 3	54 40
Sarah Island . .	61 22	55 30
Obrien's Islands .	61 28	56 35
Bridgeman's Islands .	62 00	57 12
Cape Melville . .	62 00	57 46
Sheriff Cape . .	62 28	60 57
Ditto (another account) . . .	62 21	61 47
Yankee Straits . .	62 30	60 22
Ragged Island . .	62 40	62 10
Ditto (another account) . . .	62 42S.	62 20W
Ditto the harbour (by another person)	62 55	63 5
New Plymouth .	62 45	61 37
Monroe's Island, President's Bay . .	62 46	62 20
Castle Rock (west of Monroe's I.) .	62 50	62 30
Mount Pisgah . .	63 00	63 00
Ditto (another ac'nt.	62 57	63 40

Note to page 279, Table XLVI. line 1.

I have considered the *Essex Shoal* to be the same as the *Fairlie Rock*, and have given its latitude and longitude as in Horsburgh's Directory, namely 3° 27′ S. 107° 2′ E. The place assigned by Captain Orne, of the Essex, is 3° 36′ S. 107° 00′ E. differing nine miles in latitude; and as it is possible that the rocks may not be the same, I have now given Captain Orne's estimate, made from a meridian observation two hours after *striking* on the shoal, June 26, 1804. He described it as "a small rock or coral *patch*, seen by the man at the mast head an instant before she struck; but there was no appearance of a *breaker*, though the breeze was fresh, and a short sea running. In the act of *wearing* ship, she struck rather on the side of the rock, which reduced her velocity from 8 to 2¼ knots; after rubbing a few seconds, she fell off into deeper water (8 fathoms) without any material damage."

TABLE,

Showing the TIMES of HIGH WATER at the full and change of the Moon, at the principal Ports and Harbours of the World, with the vertical rise of the Tide in feet.

PLACES.	SITUATION.	TIME.	R.	PLACES.	SITUATION.	TIME.	R.
A		H. M.	FT			H. M.	FT
Abbeville	France	10.30		Bolt Head	England	5.55	20
Aberdeen	Scotland	12.45		Bombay	India	11.15	
Aberystwith	Wales	7.30	13	Bombay Offing	India	12. 0	
Achill Head	Ireland	5.30		Borkum Island	Holland	11. 0	
Air Point	Isle of Man	10.30		Boston	England	6.45	
Aix	France	3. 0		Boston	America	11.30	11
Alban's Head (St.)	England	7.30		Botany Bay	New Holland	8. 0	
Amazon River	America	6. 0		Boulogne	France	10.45	
Ambleteuse	France	11. 0		Bourdeaux	France	3. 0	
Ameland Island	North Sea	10.30		Brassa Sound	Shetland	10. 0	8
Amelia Harbour	America	8.30		Bray Head	Ireland	3.30	
Amlwick Point	Anglesea	10.30	24	Bremen	Germany	6. 0	
Amsterdam	Holland	3. 0		Brest	France	3.45	18
Amsterdam Island	Pacific Ocean	8.30		Bridgewater	England	6.45	22
Andrew's Bay, St.	Scotland	2.15		Bridport	England	6.45	
Angra Bay	Terciera	2.20	8	Brighton	England	10. 6	16
Anholt Island	Cattegat	12. 0		Bristol	England	6.45	
Ann (Cape)	America	11.30	11	Broad Bay	America	10.45	9
Annapolis	America	11. 0		Broad Haven	Ireland	6. 0	
Anticosta I. W. end	America	3.30		Burnt Island	Scotland	2.30	14
Antwerp	France	6. 0		Button's Islands	Hudson's Bay	6.50	
Annamocka	Pacific Ocean	6. 0		C			
Archangel	Russia	6. 0		Cadiz	Spain	3. 0	
Arklow	Ireland	8.15		Caen	France	9. 0	
Artan Island	Scotland	11.15	9	Caernarvon	Wales	9. 0	22
Arundel	England	9.20	16	Calais	France	11.30	18
Augustine, (St.)	America	7.30		Caldy Island	Wales	6. 0	34
Augustine's Bay St.	Madagascar	2.15		Calf of Man	St.George's Ch.	10.30	
Avranches	France	6.00		Campbell (Port)	America	9. 0	
B				Canary Island	Atlantic Ocean	3. 0	
Babelmandel Str.	Red Sea	12. 0		Çanso (Cape)	America	8.30	
Balisore	India	9.45	12	Cantire (Mull of)	Scotland	10.30	5
Ballingskellings B.	Ireland	3.15		Capricorn (Cape)	New Holland	8. 0	7
Bally Castle	Ireland	9. 0		Cardiff	Wales	6. 0	
Bally Shannon	Ireland	6.45		Cardigan Bar	Wales	7. 0	
Baltimore	Ireland	4. 0		Carlingford	Ireland	10. 0	14
Bamff	Scotland	11.30		Carlisle	England	12. 0	
Bantry Bay	Ireland	3.30		Carmarthen	Wales	6.30	24
Bardsey Island	Wales	8.15		Carrickfergus	Ireland	10.30	8
Barfleur Cape	France	7.30		Caskets	Eng. Channel	8. 0	28
Barmouth	Wales	8. 0	13	Catherine's Pt. St.	Isle of Wight	9. 0	
Barnstable Bay	England	5.50	26	Catness	White Sea	5.15	
Baudsey Cliff	England	10.30		Cayenne	S. America	6. 0	
Bayonne	France	3.30		Charente Riv. ent.	France	4. 0	20
Beachy (on shore)	England	9.45	20	Charles (Cape)	America	7.45	
Beachy, Offing	England	11. 0		Charleston Bar	America	7.15	6
Bear Island	Hudson's Bay	12. 0		Chatham	England	1. 0	
Beaumaris	Wales	10.15	24	Chepstow	England	7.30	
Bee's Head, St.	England	11.15		Cherbourg	France	8.30	
Belfast	Ireland	10.30		Chester Bar	England	11. 0	26
Belle Isle	Bay of Biscay	3. 0		Chichester Harb.	England	11.30	18
Bembridge Point	Isle of Wight	11.40		Christmas Sound	S. America	2.30	
Bergen	Norway	1.30		Churchill (Cape)	Hudson's Bay	7.20	
Bermuda Island	Atlantic Ocean	7. 0	5	Clear (Cape)	Ireland	3.30	
Berwick	England	2.15	16	Cod (Cape)	America	11.30	6[illegible]
Biscay	Spain	3.45		Condore Pulo	China Sea	4.15	
Bilboa	Spain	3.45		Conway	Wales	10.15	24
Blakeney	England	6. 0		Copeland Island	Ireland	10.30	
Blanco (Cape)	Africa	9.45		Coringa Bay	India	9.15	
Blaskets	Ireland	3.40		Coquet Island	England	2.45	15
Block Island	America	7.37	5	Cornwall (Cape)	England	4.30	22
Boiador (Cape)	Africa	12. 0		Cornwallis (Port)	Pr. of Wales' I.	1.30	10

TIMES OF HIGH WATER.

PLACES.	SITUATION.	TIME. H. M.	R. FT	PLACES.	SITUATION.	TIME. H. M.	R. FT
Cork Harbour, en.	Ireland	4.30	18	Fly or Vlie Gatway	Holland	6.45	
Corunna	Spain	3. 0		Fly or Vlie Road	Holland	7.30	
Coutance	France	6. 0		Foreland (North)	England	11.15	16
Cowes	Isle of Wight	10.15	15	Foreland (South)	England	11. 6	15
Crocotoa Island	Str. of Sunda	7. 0	3	Formby Point	England	11. 0	26
Cromartie	Scotland	11.30	14	Fort St. John	Newfoundland	9. 0	
Cromer	England	6.45	16	Fox Island	America	10.45	
Crookhaven	Ireland	3.30		Fowey	England	5.30	16
Cross Island	White Sea	4.15		Funchal	Madeira	11.30	7
Cuxhaven	Germany	1. 0		G			
D				Gallicia (Coast of)	Spain	3. 0	
Dartmouth	England	6.10	20	Galloper	Thames River	12.45	
David's Head, (St.)	Wales	6. 0		Gallway Bay	Ireland	4.30	
Deadman's Pt.	England	5.30		Galloway, Mull of	Scotland	11.15	
Deal	England	11. 0	15	Gambia R. ent.	Africa	10.15	
Dee (River)	Scotland	11. 0		Gay Head	America	7.37	7
Delaware R. ent.	America	9. 0		George's River	America	10.45	9
Diamond Point	India	2.15		Georgetown Bar	America	7. 0	
Dieppe	France	10.30	18	Goa	India	4.30	
Dingle Bay	Ireland	3.30		Good Hope, (Cape)	Africa	3. 0	
Donnegal	Ireland	6.30		Good Hope, Town	Africa	2.30	
Dover	England	11. 6	14	Goree Gatway	North Sea	1.30	
Douglas	Isle of Man	10.30	21	Gouldsborough	America	11. 0	12
Downs	England	11. 0	15	Granville	France	7.30	
Drogheda	Ireland	10.45		Gravelines	France	11.45	18
Drontheim	Norway	2.15		Gravesend	England	1.30	16
Dublin	Ireland	9.45	12	Grizness, (Cape)	France	11. 0	
Dudgeon Lights	North Sea	6. 0		H			
Dunbar	Scotland	2. 0		Haerlem	Holland	9. 0	
Duncansbay Head	Scotland	10. 0		Hague La, (Cape)	France	8.45	
Dundalk Bay	Ireland	10.45		Halifax	Nova Scotia	7.30	8
Dundody Head	Ireland	4. 0	11	Hamburgh	Germany	6. 0	
Dundee	Scotland	2.15		Hartland Point	England	6. 0	
Dungarvon	Ireland	4.30		Hartlepool	England	3.45	
Dungeness	England	10.51	24	Harwich	England	11.30	14
Dunkirk	France	11.45	12	Hasborough Gatt	England	6.30	
Dunnose	Isle of Wight	9.15		Hastings	England	10.36	
Dursey Island	Ireland	3.30		Hatteras, (Cape)	America	9. 0	
E				Havre de Grace	France	9. 0	22
Eastern Brace	Bay of Bengal	9.45		Helena, St.	Atlantic Ocean	2.15	
Eddystone	Eng. Channel	5.50	18	Helens, St.	Isle of Wight	11.45	16
Edinburgh	Scotland	2 30		Helvoetsluys	Holland	1.30	
Elbe R. (red buoy)	North Sea	12. 0		Henlopen, (Cape)	America	8.45	5
Elizabeth Town Pt.	America	8.54	5	Henry, (Cape)	America	7.40	
Embden	Germany	12. 0		Holyhead Bay	Wales	10. 0	24
Exmouth Bar	England	6.25	14	Holy I. Harbour	England	2.30	15
Exuma Bar	Bahamas	6.35		Honfleur	France	9.30	
Eyder River	Germany	12. 0		Hull	England	6. 0	18
Eyemouth Harb.	Scotland	2.15		Humber R. ent.	England	5.15	18
F				Hurst Castle	England	9.30	
Fair Head	Ireland	9. 0		I			
Falmouth	England	5.30	18	Ice Cove	Hudson's Bay	10. 0	
Fayal Road	Azores	2.20	4½	Ipswich	England	12. 0	
Fear (Cape)	America	8. 0		Ireland, W. Coast	Atl. Ocean	5.30	
Fecamp	France	10.30		Ireland, S. Coast	Atl. Ocean	3. 0	
Ferrol	Spain	3. 0		Isle de Dieu	France	3. 0	
Ferriters	Ireland	3.30		Isle of Man, S. side	St. George's St.	10.20	
Fifeness	Scotland	2. 0		Ives, (St.)	England	5.15	24
Filey	England	4.30		Jackson, Port	New Holland	8.15	6
Finisterre (Cape)	Spain	3. 0		Janeiro Rio	S. America	4.30	
Finmark	Lapland	2.15		Johns, (St.)	Newfoundland	6. 0	
Fisguard Bay	Wales	6.30		Jutland Coast	Denmark	12. 0	
Flamboro' Head	England	4.30		K			
Florida Keys	America	8.50		Kedgeree	India	11.30	
Flushing	Holland	1. 0		Kenmare River	Ireland	3.30	

TIMES OF HIGH WATER.

PLACES.	SITUATION.	TIME. H. M.	R. FT	PLACES.	SITUATION.	TIME. H. M.	R. FT
Kennebeck	America	10.45	9	North Cape	Lapland	3. 0	
Kentish Knock	R. Thames	11.45		O			
Killibegs	Ireland	6.45		Olonne	France	3.30	
King's Channel	River Thames	12.50		Oporto	Portugal	3.15	
King's Road	Bristol Chan.	6.45		Orfordness	England	10.30	[illegible]
Kinsale	Ireland	4. 0		Orkney Islands	North Sea	10.30	[illegible]
Kinnaird's Head	Scotland	12. 0		Orm's Head	Wales	10.15	
L				Ortegal (Cape)	Spain	3 0	
Lambaness	Shetland	9.30	5	Ostend	France	12.30	[illegible]
Lancaster	England	11.15		Owers	Eng. Channel	9.36	[illegible]
Land's end	England	4.30		P			
Leith Pier	Scotland	2.20	15	Padstow	England	5.45	[illegible]
Lemon and Ower	North Sea	7. 0		Passamaquoddy R.	America	11.30	[illegible]
Lerwick	Shetland	9.45		Passier Roads	Borneo	5. 0	[illegible]
Lewis Islands	Scotland	6. 0		Penmarks	France	3.30	
Lewis (Butt of)	Scotland	6. 0		Penobscot River	America	10.45	[illegible]
Limerick	Ireland	6.30	16	Pentland Frith	Scotland	10.30	[illegible]
Lisbon	Portugal	3. 0		Penzance	England	5. 0	[illegible]
Liverpool	England	11. 0	27	Peter Head	Scotland	12. 0	
Lizard	England	5. 0		Plymouth Sound	England	6. 5	[illegible]
Loch Swilly	Ireland	6.30		Plymouth	America	11.30	[illegible]
Loire River	France	3. 0		Pol de Leon (St.)	France	5.15	
London	England	2.46	19	Poole	England	9. 0	[illegible]
Londonderry	Ireland	6. 0		Port Glasgow	Scotland	11.45	
Long Sand Head	River Thames	11.30		Port Hood	Cape Breton	7.30	[illegible]
Longships	England	4.30		Port Howe	Nova Scotia	8.30	[illegible]
Lookout (Cape)	America	9. 0	7	Port Jackson	Nova Scotia	8. 0	[illegible]
Loop Head	Ireland	4.15		Portland Bill	England	7.15	[illegible]
L'Orient	France	4. 0		Portland Race	England	9.15	[illegible]
Lundy Island	Bristol Chan.	5.45	30	Portland	America	10.45	[illegible]
Lyme Regis	England	7. 5		Port Louis	France	4. 0	[illegible]
Lynn Deeps	England	6.30		Porto Praya	C. Verd Isles	11. 0	
M				Port Roseway	Nova Scotia	8.15	[illegible]
Machias	America	11. 0	12	Port Royal Island	N. America	8.15	
Madeira	Atl. Ocean	11.30	7	Portsmouth Harb.	England	11.36	[illegible]
Malacca Roads	India	10.30		Portsmouth	America	11.15	[illegible]
Malo, (St.)	France	6.30		Portugal (Coast of)	Europe	3. 0	
Marblehead	America	11.30	11	Pulo Pinang	India	1.30	[illegible]
Margate Road	River Thames	11.45	16	Q			
Martin Vas	Atl. Ocean	3.45		Quebec	Canada	8. 0	
Marys (St.)	Scilly Islands	4.40		Queda Roads	India	10. 0	[illegible]
May (Cape)	America	8.45		R			
Milford Haven	England	6. 0		Rachlin's Island	Ireland	9. 0	
Mizen-head	Ireland	3.15		Ram Head	England	5.45	
Montrose	Scotland	1.30		Ramsey	Isle of Man	10.30	
Morocco Coast	Africa	2.15		Ramsgate	England	11. 0	
Mount's Bay	England	5. 0	19	Rhe Island	Bay of Biscay	3. 0	
Mount Desert	America	11. 0	12	Rhode-Island	America	6.45	
N				Rio Janeiro	S. America	4.30	
Nangasaki	Japan	7.53		Robin Hood's Bay	England	3.45	
Nantz	France	4. 0		Rochefort	France	3. 0	
Nantz River ent.	France	3. 0		Rochelle	France	3.45	
Nassau	N. Providence	7.30		Rochester	England	1. 0	
Natal Rivier	Africa	10. 0	12	Rodriques Island	Indian Ocean	12.45	[illegible]
Needles	Isle of Wight	9. 0		Roman (Cape)	America	8. 0	
Newcastle	England	4. 0		Roseness	Orkney	10.30	
New-Bedford	America	7.57	5	Rotterdam	Holland	3.30	[illegible]
Newburyport	America	11.15	10	Rye Harbour	England	10.51	[illegible]
New-Haven	America	10.16		S			
New-London	America	8.54		Sable (Cape)	Nova Scotia	8. 0	
Newport	Wales	6.45		Sable Island	America	8.30	
New-York	America	8.54	5	Salem	America	11.30	[illegible]
Noatka Sound	North America	12.20		Salvador (St.)	S. America	3.45	
Nore Light	River Thames	12.15	14	Sandwich	England	11. 0	
North Berwick	Scotland	2. 0		Sandwich Bay	Nova Scotia	9. 0	[illegible]

TIMES OF HIGH WATER.

PLACES.	SITUATION.	TIME. H. M.	R. FT
Sandy Hook	New-Jersey	6.37	5
Scarborough	England	4.30	13
Scaw	Denmark	12. 0	15
Scilly Islands	Eng. Channel	4.40	18
Seal Islands	Bay of Fundy	8.45	
Seine River	France	9. 0	
Selsea Bill	England	9.36	16
Selsea Harbour	England	11.15	15
Senegal R. ent.	Africa	11. 3	
Seven Islands	Lapland	9. 0	15
Shannon R. ent.	Ireland	3.45	12
Sheerness	England	12. 0	15
Sheepscut	America	10.45	9
Shetland I. S. end	North Sea	10.30	6
Shields	England	3. 0	13
Shoreham	England	9.21	16
Sierra Leon	Guinea	8.15	
Simon's Bar (St.)	America	7.30	
Skerries	Wales	10. 0	
Skerries	Scotland	5.30	
Sky Island	Scotland	6. 0	
Sligo	Ireland	6.45	
Slyne	Ireland	5.15	
Smalls	Wales	5.50	
Somme River	France	10.30	
Southampton	England	11.45	18
Southwould	England	9. 0	
Spain (N. coast of)	Bay of Biscay	3. 0	
Spurn Point	England	5.15	20
Start Point	England	5.55	20
Stockton	England	4.30	
Stonehaven	Scotland	1. 0	
Stromeness	Orkneys	10.30	
Sunbury	N. America	9.30	
Sunderland	England	2.45	12
Swansey	Wales	6. 0	20
Sweetnose	Lapland	12. 0	16
T			
Tees River	England	3.30	16
Telling (Cape)	Ireland	6. 0	
Terciera	Azores	11.45	8
Texel (ent. of)	Holland	6.45	
Texel Road	Holland	7.45	6
Thames, R. mouth	England	12. 0	
Tinmouth	England	3. 0	13
Todhead	Scotland	12.45	
Torbay	England	6.10	20
Tory Island	Ireland	6. 0	
Townsend	America	10.45	9
Tuskar Rock	Ireland	7. 0	
Typa Roads	River Canton	10. 0	6
U			
Ushant (within)	France	3.45	20
Ushant (without in the offing)	France	4.30	
V			
Vannes	France	4.30	
Vincent (Cape St.)	Spain	2.30	
W			
Wardhuys	Lapland	4. 0	
Watchet	Bristol Chan.	6.45	
Waterford Harb.	Ireland	5.30	13
Weser, River ent.	Germany	12. 0	
Western Brace	Bay of Bengal	9.36	
Wexford Harbour	Ireland	7.30	
Weymouth	England	6.15	7
Whitby	England	3.45	13
Whitehaven	England	11.15	
Wicklow	Ireland	9. 0	
Winterton	England	8.15	10
Woolwich	England	2.15	15
Wrath (Cape)	Scotland	7. 0	
Y			
Yarmouth Roads	England	8.45	
Yarmouth	Isle of Wight	9.30	12
Yorkshire Coast	England	4.30	
Youghall	Ireland	4.30	11

APPENDIX,

CONTAINING METHODS OF DETERMINING THE LONGITUDE BY OBSERVATIONS OF ECLIPSES, OCCULTATIONS, &c.

THE longitude of a place may be determined in a very accurate manner, by observing the beginning or end of a solar eclipse, or occultation of a fixed star by the moon, or the difference between the times that the moon and a known fixed star pass the meridian. These observations, when made on land with a good telescope and well regulated time-keeper, furnish by far the most accurate method of determining the longitude, and when made on board a ship without a telescope, will in general give it to a greater degree of accuracy than any other method: For this reason, it was thought proper to insert in this Appendix the usual rules of calculating such observations, by means of the Nautical Almanac. The first thing to be taken notice of, is the method of determining the longitude, latitude, &c. of the moon or other object, having regard to the unequal velocity between the times for which these quantities are given in the Nautical Almanac. This calculation is rendered much more simple by making use of the signs + and —, and performing addition and subtraction as in the introductory rules of Algebra; and as it is possible that these rules may not be familiar to some readers of this work, it was thought proper to prefix an explanation, as far as will be necessary, in the present problems.

Quantities *without a sign*, or with the sign + prefixed, are called *positive* or *affirmative*, as 7 or + 7; and those to which the sign — is prefixed, are called *negative*, as — 7. *Addition of quantities having the same sign, that is, all affirmative or all negative, is performed by adding them as in common arithmetic, and prefixing the common sign.* Thus the sum of + 4 and + 3 is + 7. The sum of — 4 — 3 and — 5 is —12. *When the quantities have not the same sign, the positive quantities must be added into one sum, and the negative into another, as above; the difference of these two sums, with the sign of the greater sum prefixed, will be the sum of the proposed quantities.* Thus the sum of + 14, — 7, +5, and — 2, is found by adding + 14 + 5, whose sum is + 19; and then — 7 and — 2, whose sum is — 9; the difference of 19 and 9 is 10, to which must be prefixed the sign of the greater number 19, which is +, so that the sought sum is + 10. The following examples will illustrate these rules.

Add + 4	Add + 4′ 10″	Add — 4′ 10″	Add — 4′ 10″	Add + 1	Add + 6′ 0″
+ 3	+ 2 5	— 2 5	+ 2 5	— 1	— 2 15
+ 7					+ 4 13
— 2	Sum + 6 15	Sum — 6 15	Sum — 2 5	Sum 0	— 3 7
Sum + 12					Sum + 4 51

Subtraction is performed by changing the sign of the number to be subtracted from + to —, or from — to +; and then adding the numbers by the preceding rule. Thus to subtract + 3 from + 7 the sign of + 3 must be changed, and the numbers — 3 and + 7 added together as in algebra, which by the preceding rule gives + 4; and if it were required to subtract — 3 from 7, the sign of — 3 must be changed, and + 3, + 7 added together. The sum + 10 represents the sought difference. It is not usual to make an actual change of the sign in any proposed question, it being sufficient to suppose the number to be subtracted to have a different sign from that prefixed to it, and to perform the operation accordingly. To illustrate this, the following examples are added.

Fro. + 4′ 10″	Fro. + 4′ 10″	Fro. — 4′ 10″	Fro. — 4′ 10″	Fro. + 1	Fro. — 1	Fro. + 1
Sub. + 2 5	Sub. — 2 5	Sub. — 2 5	Sub. + 2 5	Sub. — 1	Sub. — 1	Sub. + 1
Re. + 2 5	Re. + 6 15	Re. — 2 5	Re. — 6 15	Re. + 2	Re. 0	Re. 0

From 108	From — 108	From 108	From — 108	From — 201
Sub. 201	Sub. — 201	Sub. — 201	Sub. 201	Sub. 108
Rem. — 93	Rem. + 93	Rem. + 309	Rem. — 309	Rem. — 309

Observing that when no sign is annexed to a quantity, the sign + is always understood to be prefixed.

PROBLEM I.

To find the longitude, latitude, &c. of the moon at any given time at Greenwich, having regard to the unequal velocity between the times marked in the Nautical Almanac, The intervals of these times being 12 hours.

RULE.

Take from the Nautical Almanac the two longitudes, latitudes, &c. next preceding the given time at Greenwich, and the two immediately following it, and set them down in succession below each other, prefixing the sign + to the southern latitudes or declinations, and the sign — to the northern. Subtract each of these quantities from the following for the *first differences*, and call the middle term arch A; subtract

each first difference from the following for the *second differences*, and take the half sum or mean of them, which call the arch B, noting the signs of the quantities as in algebra.

Find the difference between the given time and the second time taken from the Nautical Almanac, which call T, then to its logarithm add the log. of A and the constant logarithm 5.36452, the sum rejecting 10 in the index, will be the logarithm of the *proportional part*,* to which prefix the sign of the arch A; observing to express all these quantities in seconds.

Enter Table XLV. with the arch B at the top and the time T at the side,† opposite to this will be the correction of second differences, to which prefix a *different sign* from that of the arch B, and place it under the proportional part found above, and the second quantity taken from the Nautical Almanac, and connect these three quantities together as in addition in Algebra; the sum will be the sought longitude, latitude, &c. The latitude or declination being *south* if it has the sign +; *north* if it has the sign —.

EXAMPLE I.

Required the longitudes and latitudes of the moon, December 12, 1808, at 15h. 48′. 29″ and 17h. 1m. 29″ app. time by astronomical computation at Greenwich, which correspond to the immersion and emersion of Spica, calculated in Problem VII.

1808. Dec. D	☽ long. N. A. s ° ′ ″	1st. diff. ° ′ ″	2d. diff. ′ ″	☽ latit. S. ° ′ ″	1st. diff. ′ ″	2d. diff. ′ ″
12 noon	6 10 45 20	7 6 16		+2 40 58	—34 21	
12 midn.	6 17 51 36	A 7 11 18	+5 2	+2 6 37	A—36 45	—2 24
13 noon	6 25 2 54	7 16 5	+4 47	+1 29 52	—38 34	—1 49
13 midn.	7 2 18 59		B=+4. 54. 5	+0 51 18		B=—2 6.5

IMMERSION.

	Constant	5.36452	....		5.36452
T= 3h. 48′ 29″= 13703″	log.	4.13701	....		4.13701
A= 7 11 18 = 25878	log.	4.41293	A=—36′ 45″=—2205″	log.	3.34341
+ 2 16 52.2= 8212.2	log.	3.91446	— 11 39.7=— 699.7	log.	2.84494
+6 17 51 36 Second longitude.			+ 2. 6 37 Second latitude.		
— 31.9 Tab. XLV. B =4′ 54″.5			+ 13.7 Tab. XLV. B=—2′ 6″.5		
6 20 7 56.3 ☽'s longitude.			+ 1. 55 11.0 ☽'s latitude south.		

EMERSION.

	Constant	5.36452	....		5.36452
T= 5h. 1′ 29″= 18089″	log.	4.25742	....		4.25742
A 7 11 18 = 25878	log.	4.41293	A=— 36′ 45″=—2205′	log.	3.34341
+ 3 0′ 36.0= 10836	log.	4.03487	— 15′ 23″ 3 =—323.3	log.	2.96535
+6 17 51 36 Second longitude.			+2 6 37 Second latitude.		
— 35.9 Table XLV. B=4′ 54″.5			+ 15.4 Tab. XLV. B=—2′ 6″.5		
6 20 51 36.1 ☽'s longitude.			+1 51 29.1 ☽'s latitude south.		

These quantities are made use of in Problem VII.

EXAMPLE II.

Required the longitudes and latitudes of the moon, June 16, 1806, at 2h. 49′ 50.″1 and 5h. 34′ 6″.6 app. time, astronomical account at Greenwich, which correspond nearly to the beginning and end of the total eclipse of the sun as observed at Salem.

1806. June.	☽ long. N. A. s ° ′ ″	1st. diff. ° ′ ″	2d. diff. ′ ″	☽ lat. N. A. ° ′ ″	1st. diff. ′ ″	2d. diff. ″
15d. midn.	2 14 48 58	7 17 21		—1 14 6	+39 53	
16 noon.	2 22 6 19	A 7 20 53	+3 32	—0 34 13	A.+40 46	+53
16 midn.	2 29 27 12	7 23 35	+2 42	+0 6 33	+40 55	+ 9
17 noon.	3 6 50 47		B=+3 7	+0 47 28		B=+31

* This may be found to minutes by Table XXX. by entering it at the top with half the arch A (because the table extends only to 3° 45′) and at the side with the time T; the result doubled will be nearly the sought proportional part; but the table not being calculated to seconds, it is hardly accurate enough to be used in calculating eclipses. This correction may also be found by proportion; by saying as 12 hours are to the time T, so is the arch A to the sought proportional part, and this method is the shortest when T is an aliquot part of 12 hours. Thus if T be 3, 6 or 9 hours, the proportional part will be ¼, ½ or ¾ of the arch A respectively. This method is made use of in Problem XVII. in interpolating the distances of the moon and sun.

† If the arch B consists of minutes and seconds, the correction for minutes, tens of seconds and units of seconds, must be found separately, the sum of these three parts will be the sought correction. Proportional parts for the minutes of the time T may be taken in finding the correction of this table when necessary. In this rule, part of the correction of third difference is neglected. This part never exceeds $\frac{1}{32}$ of the third differences, and rarely amounts to a small fraction of a second.

BEGINNING AT 2h. 49′ 50″, 1=T.

Second longitude	2s. 22° 6′ 19″	Second latitude N.	— 0° 34′ 13″
A 7° 20′ 53″ Prop. part	+ 1 43 59.8	A 40′ 46″ Prop. part	+ 9 37.0
B 3 7 Tab. XLV.	— 16.8	B 31 Tab. XLV.	— 2.8
☽'s longitude	2 23 50 2.0	☽'s latitude N.	— 0 24 38.8

END AT 5h. 34′ 6″.6=T.

Second longitude	2s. 22° 6′ 19″	Second latitude N.	— 0° 34′ 13″
A 7° 20′ 53″ Prop. part	+ 3 24 35.3	A 40′ 46″ Prop. part	+ 18 55.0
B 3 7 Tab. XLV.	— 23.2	B=31″ Table XLV.	— 3.8
☽'s longitude	2 25 30 31.1	☽'s latitude N.	— 0 15 21.8

The proportional parts of the arch A were calculated in this example by arithmetic without logarithms. By observations of the eclipse on that day, it was found that the moon's longitude was too great by 58″.5 and her latitude too great by 11″.4. These corrections are applied to the above longitudes and latitudes, in calculating the eclipse in Problem VI.

Remark 1. It will not be necessary to take notice of the second differences in calculating the parallax or semi-diameter of the moon, or any of the solar elements useful in calculating an eclipse or occultation. In this case the quantity immediately preceding and following the proposed time at Greenwich, must be taken from the Nautical Almanac, and their difference will be the arch A, also the difference between the proposed time and that taken first from the Nautical Almanac is to be called the time T. Then by proportion, as the interval between the times taken from the Nautical Almanac is to the time T, so is the arch A to the correction to be applied to the first quantity taken from the Nautical Almanac, additive if increasing, subtractive if decreasing. This correction may also be found by logarithms as above, using the constant logarithms 5.36452 if the interval of the times in the Nautical Almanac is 12 hours, and 5.06349 if the interval is 24 hours. The proportional part of the moon's parallax and semi-diameter may also be found by Table XI. and that of the solar elements by Tables XXX. XXXI. as taught in the explanation of these tables. To exemplify this, the rest of the quantities requisite in calculating the eclipse and occultation (Prob. VI. VII.) are here found.

EXAMPLE I.

1808.	☽. S.D.	☽. H.P.	1808.	⊙ long.	⊙ R. A.
Dec. 12 midn.	16′ 17″	59′ 46″	Dec. 12 noon.	8s. 20° 22′ 4″	17h. 18′ 4″ 4
Dec. 13 noon.	16 23	60 6	13 noon.	8 21 23 10	17 22 29 5
Difference A.	6	20	Difference A.	1 1 6	4 25 1
Pro. T=3h. 48′ 29″	1.9	6.3	Pro. T=15h. 48′ 29″	40 15	2 54 6
Correspond. values	16 18.9	59 52.3	Correspond. val.	8 21 2 19	17 20 59 0
Pro. T=5h. 1′ 29″	2.5	8.4	Pro. T=17h. 1′ 29″	43 21	3 8 1
Correspond. values	16 19.5	59 54.4	Correspond. val.	8 21 5 25	17 21 12 5

EXAMPLE II.

1806.	☽. S.D.	☽. S.H.	1808.	⊙ long.	⊙ R. A.
June 16 noon.	16′ 27″	60′ 21″	June 16 noon.	84° 34′ 18″	5h. 36′ 20″ 6
16 midn.	16 30	60 34	17 noon.	85 31 35	5 40 30 0
Differences A.	+ 3	+ 13	Differences A.	57 17	4 9 4
Pr. part T. 2h. 49′ 50″.1	+ 0.7	+ 3.1	Pr. part T. 2h. 49′ 50″.1	+ 6 45.4	+ 29 4
Correspond. values	16 27.7	60 24.1	Correspond. val.	84 41 3.4	5 36 50 0
Pr. part T. 5h. 34′ 6″.6	+ 1.4	+ 6.0	Pr. part T. 5h. 34′ 6″.6	+ 13 17.5	+ 57 9
Correspond. val.	16 28.4	60 27.0	Correspond. val.	84 47 35.6	5 37 18 5

The semi-diameters thus found must be decreased 2″ for inflexion, and augmented by the correction Table XLIV. in calculating an eclipse or occultation by Problem XIII. or in deducing the longitude from observations by Problems VI. VII. VIII. or IX.

The sun's semi-diameter by the Nautical Almanac, June 13, 1806, was 15′ 46″.3 and June 19, 1806, was 15′ 45″.9. Hence at the above time it was 15′ 46″.1. This in eclipses of the sun must be decreased 3½″ for irradiation.

Remark 2. The above rule for calculating the second differences of the lunar motions where the intervals in the Nautical Almanac are 12 hours, may be made use of when the intervals are three, six, &c. days, (as is the case with the elements of the motions of the planets) by taking two longitudes, latitudes, &c. before, and two after, the given time at Greenwich, and thence deducing the arches A, B, and the longitudes, latitudes, &c. and then making use instead of T, of the *quotient* of the difference between the given time and that marked in the Nautical Almanac against the second longitude, &c. divided by the number of half days in the given *interval*. Thus, if the interval is one day, the divisor is two: if the interval is 3 days, the divisor is 6; and if the interval is 6 days, the divisor is 12. Thus if it were required to find the geocentric longitude of Jupiter July 14d. 13h. 30′, 1808, astron. acc. at Greenwich, the work would be as follows.

	♃ long.					
July 7	11s. 18° 2′			Second longitude	. . . .	11s. 17° 59′ 0
13	11 17 59	— 3′	— 8	A=—11′ Prop. part	. . . . .	— 2 52
19	11 17 48	A —11	— 6	B=— 7′ Tab. XLV.	. . . . . .	+ 40
25	11 17 31	—17	B—= 7	♃ longitude	. . . . . .	11 17 56 48

In this example the time T, is 3h. 7′ 30″, found by dividing by 12, the interval between July 13 and July 14d. 13h. 30″. In general the correction of Table XLV. may be neglected in calculating the places of the planets. In the above rule the intervals of time at which the longitudes, &c. are marked in the N. A. are supposed equal. If that should not be the case, the correction Table XLV. may be neglected, on account of the trouble of calculating it.

PROBLEM II.

To find the horary motion of the moon in long. lat. &c. at any given time at Greenwich.

RULE.

Take from the Nautical Almanac the four longitudes, latitudes, &c. two immediately preceding the given time at Greenwich, and two immediately following. Prefix the sign + to the southern latitudes or declinations, and the sign — to the northern. Then find the first and second differences, the Arch B, and the time T, as in Problem I. The mean of the two first differences, noticing the signs as in algebra, will be the *approximate* motion in 12 hours.

To the proportional logarithm of one fourth part of the time T add the proportional logarithm of the arch B, the sum will be the proportional logarithm of the correction of the approximate motion, to be applied to it with *the same sign as the arch* B, and the corrected motion of the moon in 12 hours will be obtained,* which divided by 12 will give the horary motion.

EXAMPLE I.

Required the horary motions of the moon in longitude Dec. 12, 1808, at 15h. 48′ 29″ and 17h. 1′ 29″ app. time at Greenwich.

This corresponds to Example I. preceding, in which T=3h. 48′ 29″ and 5h. 1′ 29″. The two *first differences* in longitude 7° 6′ 16″ and 7° 11′ 18″; their mean 7° 8′ 47″ is the approximate motion in 12 hours, and the arch B is 4′ 54″.5. The rest of the calculation is as follows.

At 15h. 48′ 29″ T=3h. 48′ 29″				At 17h. 1′ 29″ T=5h. 1′ 29″.		
Arch B	4′ 54″ 5	P. L.	1.5644			1.5644
¼ T	57 7	P. L.	4985	¼ T 1h. 15′ 22″	P. L.	3781
Corr. +	1 33		2.0629	Corr. +	2 3 . . . . P. L.	1.9425
Approx. mot.	7 8 47			Approx. mot.	7 8 47	
Mot. 12 hours	7 10 20			Mo. 12 hours	7 10 50	
In 1 hour	35 51.7			In 1 hour	35 54.2	

In a similar manner, if the horary motion in latitude was required at 12d. 17h. 33′, the two *first differences* in latitude are — 34′ 21″, and — 36′ 45″, their mean — 35′ 33″ is the approximate motion in 12 hours. The correction found by the above rule with the time T. 5h. 33′ and the arch B=—2′ 6″.5 is — 59″, whence the true motion in 12 hours is — 36′ 32″ which divided by 12 gives the horary motion — 3′ 2″.7. The negative sign — indicates that the north polar distance is decreasing, the positive sign + that it is increasing. In the present example the north polar distance was decreasing, and as the latitude was south, it was also decreasing, as is evident.

EXAMPLE II.

Required the horary motions of the moon in longitude June 16, 1806, at 2h. 49′ 50″.1 and 5h. 34′ 6″.6 app. time by astronomical computation at Greenwich.

This corresponds to Example II. preceding, in which T=2h. 49′ 50″.1 and 5h. 34′ 6″.6; the two first differences, are 7° 17′ 21″ and 7° 20′ 53″, the mean of which 7° 19′ 7″ is the approximate motion in 12 hours, the arch B is + 3′ 7″.

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* The motion in 12 hours thus obtained, which for distinction will be called the arch M, is not perfectly accurate, since the third and higher orders of differences are neglected; but the horary motion deduced therefrom, is abundantly sufficient for the purpose of projecting an eclipse or occultation. When greater accuracy is required, the third differences may be taken into account in the following manner. Having found the *second differences* as above directed, subtract the first of them from the second, noting the signs as in Algebra, and call the remainder the arch *b*. Enter Table XLV. with this arch at the top, and the time T at the side, and take out the corresponding correction which is to be increased by one sixth part of the arch *b*, without noting the signs. To the quantity thus found is to be prefixed a sign *different from that of the arch b*, and then it is to be applied to the arch M with its sign to obtain the true motion in 12 hours. Thus in the above example the *second differences* of longitude are + 5′ 2″ + 4′ 47″. Subtracting the former from the latter, leaves the third difference or arch *b* = — 15″. Corresponding to this and the time T 3h. 48′ 29″ in Table XLV. is 1″.6 which increased by one sixth of *b* = 2″.5 gives the sought correction 4″.1 or 4″, to which must be prefixed the sign + (because the sign of *b* is negative) making it + 4″. This connected with the arch M = + 7° 10′ 20″ gives the true motion in 12 hours 7° 10′ 24″ whence the horary motion is 35′ 52″. In a similar manner, if the third differences were noticed in the above example for finding the horary motion in latitude, the two *second differences* are — 2′ 24″ and — 1′ 49″ the arch *b* = + 35″ the correction of the motion in 12 hours — 36′ 52″ is — 10″ making it — 36′ 42″ or 3′ 3″.5 per hour.

At 2h. 49′ 50″ 1=T.				At 5h. 31′ 6″.6=T			
Arch B=	+ 3′ 7″	P. L.	1.7616	. . . .			1.7616
½ Time T=	42 27	P. L.	6274	½ T=1h. 23′ 32″		P. L.	3334
Correction	+ 0 41	P. L.	2.3890	Correction	+ 1 27	P. L.	2.0950
Approx. mot.	7 19 7			. . . . . .	7 19 7		
Mot. in 12 hours	7 19 51			Mot. in 12 hours	7 20 34		
Mot. in 1 hour	36 39.2			Mot. in 1 hour	36 42.8		

EXAMPLE III.

Required the motion of the moon in right ascension in 12 hours, supposing it to increase uniformly with the velocity it had July 4th, 1808, at 9h. 26′ app. time at Greenwich, by astronomical computation.

	☽ R. A					
July 3, mid.	225°. 57′	7° 29′		B= 4′ 30″	P. L.	1.6021
4, noon	233 28	A 7 35	+6′	½ T=2h. 21 30	P. L.	1045
4, mid.	241 01	7 38	+3′	Correction + 3 32	P. L.	1.7066
5, noon	248 39		B=+4½′	Approx. mot. 7 32 0		
				True mot. in 12h. 7 35 32 or 30′.22″.1 in time.		

In this example T=9h. 26′ and the approx. motion is the half sum of 7° 29′ and 7° 35′.

REMARKS.

1. When it is required to find the motion of the moon in any given interval of time, the motion in 12 hours must be found for the middle of that interval.

2. In calculating an occultation of a star by the moon, the relative horary motion in longitude is the same as the horary motion of the moon, because the star is at rest; but in calculating a solar eclipse, the sun's horary motion must be found in page III. of the Nautical Almanac, and subtracted from the moon's horary motion in longitude, the remainder will be the *horary motion of the moon from the sun* in longitude. Thus on the 16th of June, 1806, the sun's horary motion was 2′ 23″.1, which subtracted from the horary motions found in Example II. 36′. 39″.2 and 36′. 42″.8 leaves the corresponding horary motions of the moon from the sun in longitude 34′ 16″.1 and 34′ 19″.7.

As the sun has no sensible motion in latitude, the relative horary motion of the moon from the sun in latitude, is the same as the true horary motion of the moon in latitude.

3. The horary motion of a planet may be found in a similar manner, making use of the arches A. B. T. found as in *Remark* 2, Problem I. Thus if the horary motion of Jupiter was required July 14, 1808, at 13h. 30′, the arch B= —7′ T=3h. 7′ 30″, and the approximate motion in the interval 6 days is the half sum of the two first differences—3′ and—11′, namely—7′ 0″. The correction found as in the adjoining calculation is—1′ 49″, hence the motion in 6 days is—8′ 49″, whence the horary motion is—3″,67. The negative sign indicates that the motion is retrograde, or contrary to the order of the signs: in this case the relative motion of the moon from the planet in longitude would be found by adding their horary motions, because the motion of the moon is always direct. Similar remarks may be made in finding the horary motion of the moon from the planet in latitude.

B=	—7′	P. L.	1.4102
½ T=	46 52	P. L.	5844
Corr.	— 1 49	P. L.	1.9946
Ap. mo.	— 7 0		
Motion	— 8 49 in six days.		

PROBLEM III.

To find the time of the ecliptic conjunction or opposition of the moon with the sun, a planet, or a fixed star.

The time of the ecliptic conjunction of the sun and moon is the same as the time of new moon given for the meridian of Greenwich in the first page of the month of the Nautical Almanac. Thus in January 1808, the ecliptic conjunction is on the 27th day at 4h. 9′ apparent time at Greenwich. The times of the ecliptic conjunction of the moon and those fixed stars with which there may be an occultation, are also given in the same page, being marked with Bayer's characters of reference. The time of conjunction is placed first, then the characters of the moon and star, or moon and planet. Thus in 1808, December 12d. 17h. 33′ ☽ α ♍, signifies that on the 12th day of December at 17h. 33′ apparent time at Greenwich, the moon was in ecliptic conjunction with the star Spica, whose character is α ♍, and that there might be an occultation of that star. Also, December 15, 1808, 5h. 53′ ☽ ♄ signifies that at that moment apparent time at Greenwich, the moon and Saturn were in ecliptic conjunction, and there might be an occultation of that planet. These times being reckoned according to astronomical computation, and in calculating them, no attention is paid to the parallaxes. The time of the ecliptic opposition of the sun and moon is the same as at the time of full moon given in the same page of the Nautical Almanac. Thus the full moon or ecliptic opposition in May, 1808, was 9d. 19h. 39′ at Greenwich.

The time of the ecliptic conjunction, as given in the Nautical Almanac, is easily computed from the geocentric longitudes of the objects; and as it may sometimes be required to seconds, the rule is here inserted, adapted to the calculation of the conjunction of the sun and moon, which, with a slight modification, will answer for any of the planets.

RULE.

Take from the Nautical Almanac the two longitudes of the sun and moon at the noon and midnight* preceding the time of the conjunction, and the two immediately following. Subtract the longitudes of the sun from those of the moon, noting the signs as in algebra, the remainders will represent the *distances* of the sun from the moon on the ecliptic. Subtract each of these from the following to obtain the *first differences*, and call the middle term the arch A, subtract each of these differences from the following for the *second differences*, and take their half sum or mean for the arch B, noting the signs as in algebra.

To the constant logarithm 4.63548 add the arithmetical complement of the log. of the arch A in seconds, and the log. of the second of the above found distances in seconds, the sum, rejecting 10 in the index, will be the logarithm of the approximate value of T in seconds.

With this time T at the side of Table XLV. and the arch B at the top, find the equation of second differences, the logarithm of which added to the two first logarithms used in finding T, will, in rejecting 10 in the index, give the logarithm of the correction of the approximate time T in seconds, to be applied to it with the *same sign as the arch B*, and the apparent time of the conjunction at Greenwich, counted from the second noon or midnight, taken from the Nautical Almanac, will be obtained. From which the time of conjunction under any other meridian may be easily obtained, by adding to it the longitude in time when *east*, or subtracting when *west*.

REMARK I. When the time of the ecliptic conjunction of the moon and a planet is required, the longitudes of the planet must be found by Problem I. for the noon and midnight immediately preceding, and those immediately following the time of the conjunction, and these are to be used in the above note instead of the sun's longitudes. If the ecliptic conjunction of the moon with a fixed star is required, its longitude must be found in Table XXXVII. and corrected for the equation of the equinoxes and aberration by Tables XL. XLI. as shown in the explanation of those Tables. This longitude is to be used instead of the sun's, in the above rule.

Remark II. By the same rule, the time, when the moon is at any distance from the sun, may be found, by increasing the sun's longitudes given in the N. A. by the quantity the moon is supposed to be distant from the sun, counted according to the order of the signs. Then supposing a *fictious* sun to move so as to have these increased longitudes at the corresponding times, and finding by the above rule the time of conjunction of the moon with this *fictious* sun, which will be the sought time when the moon is at the proposed distance from the sun. Thus, to find the time of the first, second, or third quarter of the moon, the sun's longitudes must be increased 3, 6, or 9 signs respectively (rejecting as usual 12 signs when the sun exceeds that quantity.) Thus, if the first quarter of the moon which happened after midnight, July 29, 1808, was required. The sun's longitudes increased by 3 signs give the longitudes of the *fictious* sun July 29d. 0h; 29d. 12h; 30d. 0h; and 30d. 12h. respectively, 7s. 6° 5′ 44″, 7s. 6° 34′ 26″, 7s. 7° 3′ 9″, and 7s. 7° 31′ 51″. The longitudes of the moon corresponding are 6s. 23° 49′ 19″, 7s. 0° 53′ 34″, 7s. 7° 57′ 30″, and 7s. 15° 0′ 57″. Hence the time of the conjunction of the moon with the *fictious* sun found by the above rule, was July 29d. 22h. 21′ at Greenwich, which is the time of the first quarter required. In a similar manner, by increasing the longitudes of a planet or a star, the time may be found when the moon is at any proposed distance from it.

EXAMPLE.

Required the time of the ecliptic conjunction of the sun and moon, in Jan. 1808?

1808, Jan.	☽ Long. s ° ′ ″	☉ Long. s. ° ′ ″	Distances. ° ′ ″	1st. diff. ° ′ ″	2d. diff. ′ ″
26d. 12h.	9 27 56 46	—10 5 57 26	—8 0 40		
27 0	10 4 25 2	—10 6 27 56	—2 2 54	+ 5 57 46	— 3 15
27 12	10 10 50 3	—10 6 58 26	+3 51 37	A = + 5 54 31	— 3 22
28 0	10 17 11 41	—10 7 28 55	+9 42 46	+ 5 51 09	B = — 3 18

			Constant	4.63548	....	4.63548
A	5° 54′ 31″ = 21271		log. co ar.	5.67221	....	5.67221
2 dis.	2 2 54 = 7374		log.	3.86770	Tab. XLV. Cor. 22″.4 log.	1.35025
T	14976″	= 4h. 9′ 36″		4.17539	Correction 45″ log.	1.65794
Correction		—45				

Conjunction 4 8 51 past noon Jan. 27, at Greenwich, apparent time, which agrees nearly with 4h. 9′ marked in the Nautical Almanac. The time of conjunc-

* The sun's longitude at midnight is the mean of the longitudes on the preceding and following noons.

tion under any other meridian, as for example 30° W. is found by subtracting the longitude 2h. from 4h. 8′ 51″, which leaves 2h. 8′ 51″. If the longitude had been 30° E. the time of conjunction would have been 6h. 8′ 51″.

The usual method of calculating the parallaxes in eclipses of the sun or occultations, is that by the *nonagesimal* or ninetieth degree of the ecliptic above the horizon. Several methods have been proposed for calculating the altitudes and longitudes of this point, which are required at each of the phases. The following, which is an improvement on that given in La Lande's Astronomy, seems well adapted to the purpose, since several of the logarithms are the same at each of the phases, which much abridges the calculation, and on this account it admits of considerable simplification, by a table like that on page 578. The method of making these calculations will first be given at full length, and then in the abridged form, by means of the proposed table.

PROBLEM IV.

Given the apparent time at the place of observation counted from noon to noon, according to the manner of astronomers, the sun's right ascension, and the latitude of the place, reduced on account of the spheroidal figure of the earth, by subtracting the reduction of latitude, Table XXXVIII. To find the altitude and longitude of the nonagesimal degree of the ecliptic.

RULE NOT ABRIDGED.

Add 6 hours to the sum of the sun's right ascension and the apparent time of observation, and call the sum the time T, rejecting 24 hours when it exceeds that quantity. Seek for this time in the column of hours of Table XXVII. supposing that marked A. M. to be increased by 12 hours, as in the astronomical computation. The corresponding log. co-tangent being found, is to be marked in the first and second columns, as in the following examples.

If the reduced latitude is *north*, subtract it from 90°; if *south*, add it to 90°, the sum or difference will be the polar distance. Take half of this, and half the obliquity of the ecliptic, and find their *difference* and *sum*. Place the log. co-sine of the difference in the first column, its log. sine in the second column: The log. secant of the *sum* in the first column, its log. co-secant in the second column, and its log. tangent in the third.

The sum of the logarithms in the first column, rejecting 20 in the index, will be the log. tangent of the arch G. The sum of these in the second column, rejecting 20 in the index, will be the log. tangent of the arch F. These arches being *less* than 90° when the time T is found in the column A. M. otherwise *greater*. This rule is general except in places situated within the polar circles. Within the *north* polar circle the supplement of F to 360° instead of F, must be taken, within the *south* polar circle the supplement of G to 180° must be taken instead of G, the other terms remaining unaltered. In all cases the longitude of the nonagesimal is equal to the sum of the arches F, G thus found, and 90°. Rejecting 360° when the sum exceeds that quantity.

Place in the third column the log. co-sine of G, and the log. secant of F, the sum of the three logarithms of this column, rejecting 20 in the index, will be the log. tangent of half the altitude of the Nonagesimal.

EXAMPLE.

Required the altitude and longitude of the Nonagesimal at Salem, in the reduced latitude 42° 22′ 4″ N. June 15, 1806, at 22h. 6′ 18″.1 apparent time by astronomical computation, when by the Nautical Almanac the sun's right ascension was 5h. 36′ 50″, and the obliquity of the ecliptic 23° 27′ 48″.

The sum of the apparent time, sun's right ascension and 6 hours, rejecting 24 hours, is 9h. 43′ 8″.1=T. The polar distance is 47° 37′ 56″, its half is 23° 48′ 58″, and the half obliquity 11° 43′ 54″, hence their difference is 12° 5′ 4″, their sum 35° 32′ 52″. The rest of the calculation is as follows:

Col. 1.		Col. 2.		Col. 3.	
Diff. 12° 5′ 4″ co-sine	9.99027	Sine	9.32088		
Sum 35 32 52 sec.	10.08957	Co-secant	10.23554	Tangent	9.85403
T. 9h. 43′ 8″.1 P. M. cot.	9.48826		9.48826	G. Co-sine	9.97215
				F. Secant	10.00265
G. 159° 42′ 0″ Tan.	9.56810	F. Tan.	9.04468		
F. 173 40 31				33° 59′ 25″=Tan.	9.82883
90					
				67 58 50 = Alt. Nonang.	

Sum 63 22 81 rejecting 360°, is longitude Nonages.

The two upper logarithms of the first and second columns, and the upper logarithm of the third column, vary but little in several centuries; and as these numbers occur

twice in calculating a partial eclipse or occultation, and four times in a total, or annular eclipse or transit, it will tend considerably to abridge the calculations, to have a table like the following, containing their values for various places, for the obliquity 23° 27′ 40″, with the variations for an increase of 100″ in the latitude or obliquity. The logarithms A, B, C, of the table, were calculated in the following manner.

In *north* latitudes subtract the reduced latitude from 90°, in *south* latitudes add the reduced latitude to 90°, the sum or difference will be the polar distance; take half of this and half of the obliquity of the ecliptic 11° 43′ 50″, and find the *sum* and *difference*. Then

Log. A is equal to the log. co-sine of the *difference* added to the log. secant of the *sum*, rejecting 20 in the index.

Log. C is equal to the log. tangent of the sum.

Log. B is equal to the log. tangent of the difference, increasing the index by 10, less the log. C.

Thus for Salem in the reduced latitude 42° 22′ 4″, the half polar distance is 23° 48′ 58″, the half obliquity 11° 43′ 50″, the *difference* 12° 5′ 8″, the *sum* 35° 32′ 48″.

Difference........12°	5′	8″	Co-sine	9.99027		Tang.+10=	19.33065
Sum 35	32	48	Secant	10.08956		Tang.=C =	9.85402
		Sum A................		0.07983		Diff. ....B	9.47663

In this way the logarithms may be found for places not included in the table. The changes for an increase of 100″ in the latitude or obliquity, are found by repeating the operation with these increased values, and ascertaining the corresponding changes in the values of A, B, C. These logarithms are given to six places of figures, though in general five will be quite sufficient, since the latitude and longitude of the nonagesimal are rarely required to a greater degree of accuracy than 10″.

Places.	Reduced Latitude North.			A.	Var A. +100″.		B	Var. B. +100″.		C.	Var. C. +100″.	
					Lat.	Obl.		Lat.	Obl.		Lat.	Obl.
	°	′	″		—	+		—	+		—	+
Albany	42	27	13	0.079670	53	97	9.475733	293	739	9.858326	225	22[illegible]
Berlin	52	20	24	0.061608	49	75	9.324135	618	1099	9.771197	240	240
Cambridge, E.	52	1	28	0.062166	49	76	9.331054	600	1080	9.773925	240	240
Cambridge, A.	42	12	2	0.080150	52	97	9.478383	288	733	9.855355	222	22[illegible]
Dublin obs.	53	12	7	0.060090	48	73	9.304166	670	1155	9.763705	242	24[illegible]
Edinburgh	55	46	2	0.055618	47	67	9.285401	878	1376	9.741011	249	249
Greenwich obs.	51	17	28	0.063466	49	77	9.346306	562	1038	9.780232	238	238
Havanna	23	3	34	0.120000	64	148	9.597658	95	516	10.006045	210	210
Kinderhook	42	11	37	0.080163	52	98	9.478455	289	735	9.855411	222	222
Lancaster	39	51	18	0.084648	54	104	9.501042	249	688	9.874005	219	219
Leon I. obs.	36	16	52	0.091680	55	112	9.529940	202	634	9.902005	216	21[illegible]
London	51	19	29	0.063106	49	77	9.345714	564	1040	9.779944	238	23[illegible]
Natchez	31	17	36	0.101899	58	125	9.561510	152	577	9.940447	212	21[illegible]
Oxford obs.	51	34	28	0.062963	50	77	9.340586	576	1054	9.777800	259	23[illegible]
Paris	48	38	51	0.068207	50	83	9.394413	452	916	9.802627	235	23[illegible]
Philadelphia	39	45	41	0.084828	53	104	9.501872	248	687	9.874738	219	21[illegible]
Richmond obs.	51	16	56	0.063482	49	78	9.346576	562	1038	9.780308	238	23[illegible]
Rutland	43	24	32	0.077866	52	95	9.465330	312	760	9.845648	224	224
Salem	42	22	4	0.079832	52	98	9.476637	291	731	9.854016	222	222
Place Prob. VII.	19	52	38	0.127485	66	157	9.607602	78	500	10.027183	211	211

These logarithms are calculated for the obliquity 23° 27′ 40″. The columns marked *Lat.* represent the variations of A, B, C, for an increase of 100″ in the reduced lat. The column *Obl.* represents the variations of A, B, C, for an increase of 100″ in the obliquity of the ecliptic. The signs must be changed if the latitude or obliquity is less than that used in calculating the table.

EXAMPLE.

Required the values of A, B, C, for Salem, when the obliquity is 23° 27′ 48″?

Tabular numbers	0.079832	9.476637	9.854016
Var. for + 8″ Obl.	+ 8	— 58	+ 18
Sought values	A=0.079840	B=9.476579	C=9.854034

Abridged method of calculating the altitude and longitude of the Nonagesimal, by the preceding Table.

Add together the sun's right ascension, the apparent time at the place of observation, (counted from noon to noon) and 6 hours, the sum, rejecting 24 or 48 hours if greater than those quantities, is to be called the time T; this is to be sought for in the column of hours of Table XXVII. supposing the column marked A. M. to be increased 12 hours, as in the astronomical computation.* The corresponding log. co-tangent, added to the log. A of the Table, gives the log. tangent of the arch G; this added to the log. B of the Table, rejecting 10 in the index, will be the log-tangent of the arch F; these arches being *less* than 90° when T is found in the column A. M. otherwise *greater*.† [This rule is general, except in places situated within the polar circles, which is a case that very rarely occurs. Within the *north* polar circle, the supplement of F to 360°, is to be used instead of F; within the *south* polar circle, the supplement of G to 180°, is to be taken instead of G, the other terms remaining unaltered.] Then the *longitude of the Nonagesimal* is equal to the sum of the arches F, G, and 90°, neglecting as usual 360° when the sum exceeds that quantity.

To the tabular log. C, add the log. co-sine of the arch G, and the log. secant of the arch F, the sum, rejecting 20 in the index, will be the log-tangent of half the altitude of the Nonagesimal.‡

EXAMPLE I.

Required the altitudes and longitudes of the Nonagesimal at Salem, June 16, 1806, at the times of the beginning and end of the eclipse, calculated in Problem VI.?

Beginning of the Eclipse.

	h.	′	″				
	5	36	50.0	⊙ R. Ascension			
	22	6	18.1	Apparent time			
	6			A	0.07934		
T	9	43	8.1	Co-tan.	9.48826		
G	159°	42′	0″	Tan.	9.56810	Co-s.	9.97216
	90			B	9.47658	C	9.85408
F	173	40	31	Tan.	9.04468	Sec.	10.00265
	63	22	31=lon.	N.	33 59 25	Tan.	9.82883
Altitude Nonages					67 58 50		

End of the Eclipse.

	h.	′	″				
	5	37	18.5	⊙ R. Ascension			
	0	50	34.6	Apparent time			
	6			A	0.07984		
T	12	27	53.1	Co-tan.	8.78470		
G	4°	11′	13″	Tan.	8.86454	Co-s.	9.99884
	90			B	9.47658	C	9.85403
F	1	15	23	Tan.	8.34112	Sec.	10.00010
	95	26	36= lon.	N.	35 28 53	Tan.	9.85297
Altitude Nonages					70 57 46		

EXAMPLE II.

Required the altitudes and longitudes of the Nonagesimal at the times and places mentioned in the Example of Problem VII.?

Immersion.

	h	′	″				
	17	20	59	⊙ R. Ascension			
	16	57	29	Apparent time			
	6			A	0.12748		
T	16	18	28	Co-tan.	9.80098		
G	40°	18′	7″	Tan.	9.92846	Co-s.	9.88233
	90			B	9.60761	C	10.02713
F	18	57	48	Tan.	9.53607	Sec.	10.024[illegible]3
	149	15	55=lon.	N.	40 53 46	Tan.	9.93374
Altitude Nonages					81 17 32		

Emersion.

	h	′	″				
	17	21	12.5	⊙ R. Ascension			
	18	10	29	Apparent time			
	6			A	0.12748		
T	17	31	41.5	Co-tan.	9.94622		
G	49°	50′	18″	Tan.	10.07370	Co s.	9.80953
	90			B	9.60761	C	10.02718
F	25	38	40	Tan.	9.68131	Sec.	10.04504
	165	28	58=lon.	N.	37 17 39	Tan.	9.88175
Altitude Nonages					74 35 18		

In these calculations it is usual to take the sun's right ascension, and the apparent times, to tenths of a second, and to take proportional parts for the seconds and tenths in finding the logarithms. Thus in Example I. in finding the log. co. tang. of 9h. 43′ 8″.1; the nearest logarithms are 9.48849, 9.48804, corresponding to the 9h. 43′ 4″, and 9h. 43′ 12″. These logarithms differ 45, the times 8″, and the difference between 9h. 43′ 4″, and 9h. 43′ 8″.1, is 4″.1. Hence 8″ : 45 :: 4″.1 : 23 the correction to be subtracted from the first log. 9.48849, (because it is decreasing) to obtain the sought log. co-tang. 9.48826.

* Thus if the time T is 5 hours, it must be called 5h. P. M. If T is 14 hours, it must be called 2h. A. M. In making use of a common table of logarithms, you must turn the time T into degrees, and make use of the log. co-tangent of its half.

† The arches F, G, are *acute* when the time T is found in the column A. M. otherwise *obtuse*. This is easily remembered from the circumstance that *a* is the first letter of *acute* and A. M. Some writers have not taken notice of the cases of the values of F. G, within the polar circles.

‡ Strictly speaking, the quantity thus obtained is the distance between the north pole of the ecliptic and the zenith of the place, which, in southern latitudes, and between the tropics, is frequently the supplement of the altitude of the Nonagesimal. The above form is made use of to simplify the rules for applying the parallaxes. It is immaterial whether the altitude of the Nonagesimal, or its supplement, is made use of in Table XLIV.

PROBLEM V.

Given the altitude and longitude of the Nonagesimal; the longitude, latitude and horizontal parallax of the moon, and the latitude of the place of observation, to find the moon's parallax in latitude and longitude.

RULE BY COMMON LOGARITHMS.

From the horizontal parallax of the moon, subtract its correction from Table XXXVIII. corresponding to the latitude of the place, the remainder, in occultations of a fixed star, will be the *reduced* parallax; but in solar eclipses this quantity is to be diminished by the sun's horizontal parallax, 8″. 8* to obtain the *reduced* parallax.

To the logarithm of the reduced parallax in seconds, add the log. sine of the altitude of the Nonagesimal, and the log. secant of the moon's *true* latitude†, the sum, rejecting 20 in the index, will be a constant log. From the moon's true longitude,† increased by 360° if necessary, subtract the longitude of the Nonagesimal, the remainder will be the *moon's distance from the Nonagesimal*, which if less than 180° is to be called the arch D, otherwise its supplement to 360° is to be called the arch D. To the constant logarithm, add the log. sine of D, the sum, rejecting 10 in the index, will be the logarithm of the *approximate* parallax in longitude in seconds, which add to the arch D, then take the log-sine of the sum, and add it to the constant logarithm, rejecting 10 in the index, and the logarithm of the *corrected* parallax will be obtained. This will in general be sufficiently exact, but when great accuracy is required, the operation may be again repeated, by adding the arch D to the *corrected* parallax;§ then to the log. sine of the sum add the constant logarithm, rejecting 10 in the index, and the logarithm of the *parallax in longitude* P will be obtained. This is to be *added* to the *true* longitude of the moon when her distance from the Nonagesimal is *less* than 180°, otherwise *subtracted* to obtain her *apparent longitude.*

If the true latitude of the moon is *south*, prefix the sign + to it, if *north* the sign —. Then to the logarithm of the reduced parallax in seconds, add the log. co-sine of the altitude of the Nonagesimal, and the log. co-sine of the moon's apparent latitude,‖ the sum, rejecting 20 in the index, will be the logarithm of the *first* part of the parallax in latitude in seconds, to which prefix the sign + when the altitude of the Nonagesimal is less than 90°, otherwise the sign —, this added to the true latitude of the moon, due regard being had to the signs, will give her *approximate* latitude.

To the logarithm of the reduced parallax in seconds add the log. sine of the altitude of the Nonagesimal, the log. sine of the moon's approximate latitude, and the log. co-sine of the sum of the arches D and ½ P, the sum, rejecting 30 in the index, will be the logarithm of the *second part* of the parallax in latitude in seconds, to which prefix the sign — when the arches D + ½ P, and the approximate polar distance¶ are both greater or both less than 90°, otherwise the sign +, this term connected with the approximate latitude will give the *apparent latitude* of the moon,** which will be south if + north if —. The moon's *true* latitude subtracted from her *apparent* latitude, noticing the signs, will give the *parallax in latitude.*

BY PROPORTIONAL LOGARITHMS.

The above rule will answer in calculating by proportional logarithms, with the following alterations. When the log. *sine* occurs, read log. co-secant; for log. *co-sine* read log. secant; for log. *secant* read log. co-sine; and for log. *co-secant* read

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* This is the mean value of the sun's parallax, and may be used instead of the true parallax, which varies from 8″.7 to 8″.9. The true solar parallax at any time may be found by subtracting the logarithm of the sun's distance, given in the Nautical Almanac, from the log. of 8″.8, increasing the index by 10 when necessary, the remainder will be the logarithm of the sought parallax in seconds.

† Corrected for the errors of the tables, when known.

§ This sum D + cor. par. is nearly equal to D + P the apparent distance of the moon from the Nonagesimal, to be made use of in Table XLIV. in finding the augmentation of the moon's S. D.

‖ In *solar eclipses* the apparent latitude is so small that its log. sine may be put equal to 10.00000. In *occultations* you must calculate the first part of the parallax in altitude by approximation, making use of the *true* latitude instead of the *apparent* in the above rule, and deducing the approximate value of the *first part* of the parallax: this applied to the *true* latitude will give the *approximate* apparent latitude, with which the operation is to be repeated, and the first part of the parallax will be obtained to a sufficient degree of exactness.

¶ The apparent polar distance is found by adding + 90° to the approximate latitude, due regard being had to the signs. To be perfectly accurate, the *apparent* instead of the *approximate* latitude ought to be made use of in this part of the calculation, and the logarithms of this term ought to be increased by the log. secant less radius of ½ P; but these corrections are too small to affect the result. In calculating the second part of the parallax in latitude, it will be sufficient to take the logarithms to three or four places of the decimals.

** This rule gives the apparent latitude in all cases, but it may not be amiss to observe, that in several late publications the cases where the moon is between the zenith and the elevated pole are by mistake neglected.

log. sine. The parallaxes may be calculated to the nearest second by proportional logarithms. When greater accuracy is required, common logarithms must be made use of.

To illustrate this rule, the following examples, corresponding to the times of the beginning and end of the total eclipse of the sun, of June 16, 1806, as observed at Salem, are given. The elements necessary for this purpose have already been calculated in Problems I. and IV. For greater accuracy the longitudes and latitudes of the moon are corrected for the errors—58″.5 in longitude, and — 11″.4 in latitude, which were found by comparing several observations of the eclipse made at different places.

EXAMPLE I.

Given the altitude of the Nonagesimal 67° 58′ 50″, its longitude 63° 22′ 31″, the longitude of the moon 83° 49′ 3″.5 her latitude 24′ 27″.4 N. her horizontal parallax 60′ 24″.1, the latitude of the place of observation 42° 33′ 30″: required the parallaxes in longitude and latitude?

The correction in Table XXXVIII. corresponding to the latitude 42° 33′ 30″, and parallax 60′ 24″.1 is 5″.6, this and the sun's horizontal parallax 8″.8 subtracted from the ☽'s horizontal parallax 60′ 24″.1 leaves the *reduced* parallax 60′ 9″.7=3609″.7. The longitude of the Nonagesimal 63° 22′ 31″ subtracted from the moon's longitude 83° 49′ 3″, leaves the *moon's distance from the Nonagesimal*, 20° 26′ 32″ equal to the arch D, because less than 180°.

Calculation by common Logarithms.

Reduced par.	3609″ 7	Log.	3.55747
Alt. Nonag.	67 58 50	Sine	9.96710
☽'s true lat.	24 27.4	Sec.	10.00001
Constant log.			3.52458
D	20 26 32	Sine	9.54315
Appr. par.	1169″=19 29	Log.	3.06773
D + Appr. par.	20 46 1	Sine	9.54970
Constant log.			3.52458
Cor. par.	=1187″=19 47	Log.	3.07428
D + cor. par.	20 46 19.	Sine	9.54980
Constant log.			3.52458
Par. long. P	1186″.8=19′ 46.8	Log.	3.07438
☽'s true longitude	83 49 3.5		
☽'s app. long.	84 8 50.3		

Reduced par.		3609 7	Log.	3.55747
Alt. Nonag.		67 58 50	Co-si.	9.57394
☽'s app. lat.			Co-si.	10.00000
1 prt. p. 1353″.3	= +	22′ 33″.3	Log.	3.13141
☽'s true latitude	—	24 27.4		
☽'s approx. lat.	—	1 54.1	Sine	6.743
Reduced parallax			Log.	3.557
Alt. Nonag.			Sine	9.967
D + ½ P		20 36 25	Co-si.	9.971
2 part par.	—	1″.7	Log.	0.238
Approx. lat.	—	1 54 1		
☽'s app. lat.	—	1 55 8 or		1′ 55″.8 N.

EXAMPLE II.

Given the altitude of the Nonagesimal 70° 57′ 46″, its longitude 95° 26′ 36″, the longitude of the moon 85° 29′ 32″.6, her latitude 15′ 10″.4 N. her horizontal parallax 60′ 27″.0, the latitude of the place of observation 42° 33′ 30″. Required the parallaxes in longitude and latitude?

The correction in Table XXXVIII. corresponding to the latitude 42° 33′ 30″ and parallax 60′ 27″, is 5″.6, this and the sun's horizontal parallax 8″.8, subtracted from the moon's horizontal parallax 60′ 27″.0 leaves the *reduced* parallax 60′ 12″.6. The longitude of the Nonagesimal 95° 26′ 36″, subtracted from the moon's longitude increased by 360°, viz. 445° 29′ 33″, leaves the *moon's distance from the Nonagesimal* 350° 2′ 57″, the supplement of which to 360° is 9° 57′ 3″, equal the arch D.

By proportional Logarithms.

Reduced par.	60′ 12″.6	P. L.	0.4756
Alt. Nonag.	70 57 46	Co-se.	10.0244
☽'s true lat.	15 10.4	Co-si.	10.0000
Constant log.			0.5000
D	9 57 3	Co-se.	10.7624
Approx. par.	9 50	P. L.	1.2624
D + appr. par.	10 6 53	Co-se.	10.7554
Constant log.			0.5000
Corrected par.	10 0	P. L.	1.2554
D + cor. par.	10 7 3	Co-se.	10.7553
Constant log.			0.5000
Par. long. P.	10 0.0	P. L.	1.2553
☽'s true long.	85 29 32.6		
☽'s app. long.	85 19 32.6		

Reduced par.		60′ 12″.6	P. L.	0.4756
Alt. Nonag.		70 57 46	Sec.	10.4865
☽'s app. lat.			Sec.	10.0000
1 part par. lat.	+	19 38 5	P. L.	0.9621
☽'s true lat.	—	15 10 4		
☽'s appr. lat.	+	4 28 1	Co-se.	12.886
Reduced par.			P. L.	0.4756
Alt. Nonag.			Co-se.	10.0244
D + ½ P		10 2 3	Sec.	10.0067
2 part par. lat.	+	4.4	P. L.	3.3927
Approx. lat.	+	4 28.1		
Apparent lat.	+	4 32.5 or		4′ 32″.5 S.

EXAMPLE III.

Required the parallaxes in longitude and latitude at the time of the occultation of Spica, Dec. 12, 1808, at the times and place mentioned in the Example of Problem VII.

Immersion.

Reduced par.	59′ 50″.9	P. L.	0.4782	. . . .				0.4782
Alt. Non.	81 17 32	Co-se.	10.0050	. . . .			Sec.	0.8199
☽'s true lat.	1 55 11	Co-si	9.9998	☽ app. lat.*			Sec.	10.0003
Constant			4830	1 part par. lat.	+	9′ 3″.9	P. L.	1.2984
D	50 52 1	Co-se.	10.1103	☽ true lat.	+	1 55 11.0		
Appr. par.	45 55	P. L.	5933	☽ approx. lat.	+	2 4 14.3	Co-se.	11.4421
D + appr. par.	51 37 56	Co-se.	10.1057	Reduced par.			P. L.	0.4782
Constant			4830	Alt. Nonag.			Co-se.	10.0050
Corrected par.	46 25	P. L.	5687	D + ½ P		51 15 13	Sec.	10.2035
D + corr. par.	51 38 26	Co-se.	10.1056	2 part par. lat.	+	1 20.5	P. L.	2.1288
Constant			4830	☽ approx lat.	+	2 4 14.3		
Par. long. P.	+ 46 25	P. L.	5886	☽ app. lat.	+	2 5 34.6 South.		
☽ true long.	200 7 56.3			☽ par. lat.	+	10 23.6		
☽ app. long.	200 51 21.3							

Emersion.

Reduced par.	59′ 53″.0	P. L.	0.4780	. . . .				0.4780
Alt. Non.	74 35 18	Co-sec.	10.0159	. . . .			Sec.	10.5755
☽ true lat.	1 51 29.1	Co-si.	9.9998	☽ app. lat.			Sec.	10.0003
Constant			0.4937	1 part par. lat.	+	15′ 54″.2	P. L.	1.0558
D	35 22 38	Co-sec.	10.2374	☽ true lat.	+	1 51 29.1		
Appr. par.	33 26	P. L.	7311	☽ approx. lat.	+	2 7 23.3	Co-sec.	11.4313
D + appr. par.	35 56 4	Co-sec.	10.2315	Reduced par.			P. L.	0.4780
Constant			4937	Alt. Nonag.			Co-sec.	10.0159
Corrected par.	33 54	P. L.	7252	D + ½ P		35 39 35	Sec.	10.0912
D + corr. par.	35 56 32	Co-sec.	10.2314	2 part par lat.	+	1 41.2	P. L.	2.0154
Constant			4937	☽ approx. lat.	+	2 7 23.3		
Par. long. P.	+ 33 54	P. L.	7251	☽ appar. lat.	+	2 9 7.5 South		
☽ true long.	200 51 36.1			☽ par. lat.	+	17 38.4		
☽ app. long.	201 25 30.1							

Having thus explained the method of calculating the parallaxes of the moon, it now remains to give the rules for finding the longitude by eclipses and occultations. The main object in these calculations is to determine from the observed beginning or end of the eclipse or occultation, the precise time of the ecliptic conjunction of the sun, or star and moon, free from the effects of parallax, counted on the meridian of the place of observation, since the difference of the times of conjunction, obtained in this manner at two places, will be their difference of longitude. If the lunar and solar tables were perfectly correct, the longitude might be determined by taking the difference between the time of conjunction, given in the Nautical Almanac, and that deduced from the observations of the eclipse or occultation; but it is much more accurate to compare the times deduced from observations actually made at the places for which the difference of longitude is sought. There are two different methods of finding the ecliptic conjunction, according as the latitude of the moon is supposed to be accurately known or not. If the latitude was given correctly by the lunar tables, or was accurately known by other observations, the ecliptic conjunction, and the longitude of the place, might be determined by each of the phases of the eclipse or occultation, by the method given in Problems VIII. and IX. But the moon's latitude not being generally given to a sufficient degree of accuracy, it is usual to combine together the observations of the beginning and end of the eclipse or occultation, or the beginning and end of total darkness in a total eclipse, or the two internal contacts of an annular eclipse, to ascertain the error of the moon's latitude, by the method given in Problems VI. and VII. In making the calculations in these Problems, it will be necessary to know nearly the longitude of the place, in order to find the supposed time at Greenwich, so as to take out the elements from the Nautical Almanac: and if the longitude, deduced from the observation, should differ considerably, the operation must be repeated with the longitude obtained by this operation.

* The moon's true latitude 1° 55′ 11″ must first be used, its log. secant being 10.0002, which give the 1st part par. 9′ 3″, which, added to the true latitude of the moon, gives the app. lat. nearly 2° 4′ 14″ the log. secant of which is 10.0003, as above. The calculation for the emersion is made in a similar manner.

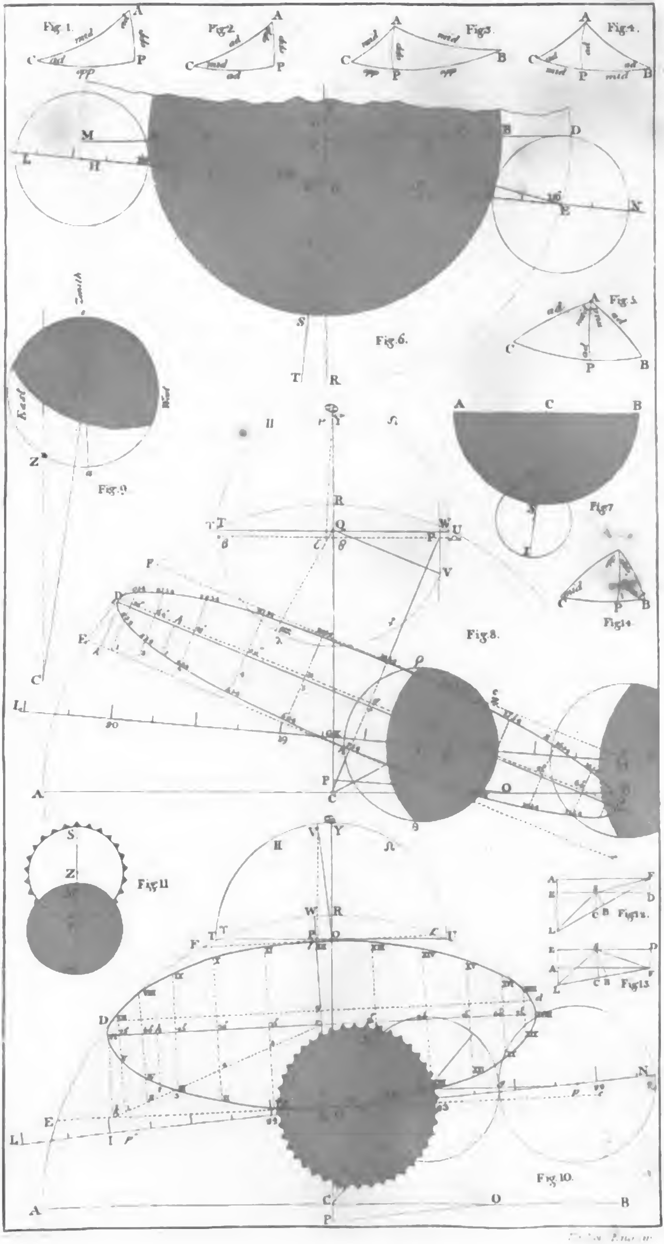
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10.
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.

PROBLEM VI.

Given the latitude of the place, and the apparent times of the beginning and end of a solar eclipse, counted from noon to noon, according to the method of Astronomers, to find the longitude of the place of observation.

In the rule for solving this Problem, references will be made to fig. 12, Plate XII. in which DSE represents a small arch of the ecliptic; S, the place of the centre of the sun, supposed at rest; F, L, the apparent places of the centre of the moon at the beginning and end of the eclipse respectively; FD, SC, and AEL, are perpendicular to DE, FA parallel to DE, and SB perpendicular to FL. Then it is evident that FD, LE represent the apparent latitudes of the moon, which fall below DE if *south*, above if *north;* and SF, SL represent the sums of the corrected semi-diameters of the sun and moon, at the beginning and end of the eclipse respectively.

RULE.

To the apparent times of the beginning and end of the eclipse add the estimated longitude of the place in time if it is *west*, but subtract if *east;* the sum or difference will be the supposed time at Greenwich, corresponding to which, in the Nautical Almanac, find, by Problem I. the moon's semi-diameter, horizontal parallax, longitude and latitude,* and the sun's semi-diameter, longitude and right ascension, also the moon's horary motion from the sun, by Problem II. Decrease the sun's semi-diameter $3\frac{1}{2}''$ for irradiation, and the remainder will be his *corrected* semi-diameter. Decrease the moon's semi-diameter $2''$ for inflexion, and to the remainder add the correction in Table XLIV.† the sum will be the moon's *corrected* semi-diameter. Find also, in the Nautical Almanac, the obliquity of the ecliptic.

With these elements and the apparent time at the place of observation, calculate the altitudes and longitudes of the Nonagesimal, by Problem IV. the parallaxes in longitude and latitude, and the moon's apparent longitudes and latitudes, by Problem V.

Take the difference between the *apparent* longitudes of the moon at the beginning and end of the eclipse, and subtract therefrom the difference of the sun's longitudes at the same times, the remainder will be the relative motion in longitude DE or FA. The relative motion in latitude AL, is found by taking the difference of the moon's *apparent* latitudes at the beginning and end of the eclipse, if they are both north, or both south, but their sum, if one be north, the other south. From the logarithm of FA, increasing the index by 10, subtract the logarithm of AL, the remainder will be the log-tangent of the *angle of inclination* DSB; this angle is to be taken *greater* than 90° when the moon's apparent latitude FD, at the beginning of the eclipse, is *greater* than at the end EL, otherwise less.‡ Then to the log. co-secant of the angle of inclination, add the logarithm of the relative motion in longitude FA, the sum, rejecting 10 in the index, will be the logarithm of the apparent motion of the moon FL on her relative orbit. Then in the triangle SFL, the sides SF, SL, represent the sums of the *corrected* semi-diameters of the sun and moon at the beginning and end of the eclipse, and these with the relative motion FL, are given to find the angle FSB, (by Case VI. Obl. Trig.) Thus: to the log. ar. co. of FL, add the log. of the sum of SF and SL, and the log. of their difference, the sum, rejecting 10 in the index, will be the logarithm of the difference of the segments FB, BL; half of which, added to, and subtracted from half of FL, will give the two segments FB, BL, the greater segment being contiguous to the greater side, whether SF or SL. Then from the logarithm of the segment FB, increasing the index by 10, subtract the log. of SF, the remainder will be the log. sine of the angle FSB,‖ which is always less than 90°:

* Corrected for the errors of the tables in longitude and latitude, when known.

† This correction must be found after the altitude and longitude of the Nonagesimal are calculated.

‡ This rule is equally true whether the latitude be of the same or different names. If the latitudes are equal and of the same name, the angle DSB will be 90°. If they are equal, but of different names, the angle DSB may be taken acute or obtuse, since in that case the angle FSB is 90°. Strictly speaking, when the points F, L. fall on different sides of the line DE, the angle DSB is *greater* or *less* than 90°: according as the expression $\frac{FD}{SF}$ is *greater* or *less* than $\frac{EL}{SL}$ but as the divisors SL and SF are nearly equal, they may be neglected, (as in the above rule) except in a case which very rarely occurs, namely, when the difference of SL SF is greater than the difference of the two app. latitudes EL, FD, in which case the rule in this note must be made use of. Observing that the fractions $\frac{EL}{SL}$ $\frac{FD}{SF}$ represent the quotients of the moon's apparent latitudes divided by the sum of the semi-diameters of the sun and moon.

‖ When SF, SL are equal, or their difference is so small that it may be neglected, the log. sine of the angle FSB may be obtained much more expeditiously by subtracting the log. of the sum of SF and SL, from the log. of FL increasing the index by 10. This method may almost always be made use of without much error. It is the rule adopted by Doctor Mackay in his treatise on longitude.

the difference between this and the angle of inclination DSB, will be the *central angle* DSF.

To the log. co-sine of the *central* angle, add the log. of the sum of the corrected semi-diameters at the beginning of the eclipse SF, rejecting 10 in the index, the sum will be the logarithm of SD, the apparent difference of longitude of the sun and moon at that time. This is to be subtracted from the longitude of the sun at the beginning of the eclipse, if the central angle is less than 90°, but added if greater than 90°, the sum or difference will be the moon's apparent longitude: to this must be *added* the moon's parallax in longitude, when her distance from the Nonagesimal (found as in Problem V. by subtracting the longitude of the Nonagesimal from the moon's longitude, borrowing 360° when necessary,) is greater than 180°, otherwise the parallax must be *subtracted;* the sum or difference will be the moon's *true longitude* at the beginning of the eclipse.

Take the difference in seconds, between the sun's and moon's *true* longitudes at the beginning of the eclipse, to the logarithm of which add the arith. comp. log. of the moon's horary motion from the sun* in seconds, and the constant logarithm 3.55630: the sum, rejecting 10 in the index, will be the logarithm of the time from the conjunction in seconds, which is to be added to the observed apparent time of the beginning of the eclipse, when the sun's longitude at that time is greater than the moon's *true* longitude, otherwise subtracted; the sum or difference will be the apparent time of the true ecliptic conjunction of the sun and moon at the place of observation. The difference between this and the time of conjunction at Greenwich, inferred from the Nautical Almanac by Problem III. will be the longitude of the place of observation. But if corresponding observations have been made at different places, it will be much more accurate to find the times of the conjunction at each place by the above rule, and the difference of those times will be the difference of meridians, if it does not differ much from the supposed difference of longitude. If there is considerable difference, the operation must be repeated, making use of the longitude found by this operation; and thus by successive operations, the true longitude may be obtained.

The long. of the place of observation being accurately known, the errors of the lunar tables in long. and latitude may be easily found. For the difference between the moon's *true* longitude deduced by the above method from the observations, and the longitude found from the Nautical Almanac, will be the error of the tables in longitude. To find the error in latitude, add the log. sine of the central angle DSF to the log. of the sum of the corrected semi-diameters at the beginning of the eclipse SF, the sum, rejecting 10 in the index, will be the logarithm of the moon's apparent latitude FD at that time, which will be south, if the point F falls below D, otherwise north. Take the difference between this and the moon's apparent latitude found by Problem V. if they are both north, or both south; but their sum, if one be north and the other south, and the error of the tables in latitude will be obtained.†

REMARK.

The above rule will answer for deducing the longitude from the observed beginning and end of the internal contacts of a total or annular eclipse. The differences consist in reading the rule, beginning and end of the internal contacts, instead of beginning and end of the eclipse, and taking SF, SL equal to the differences of the corresponding semi-diameters, instead of their sums.

EXAMPLE.

At Salem, in the latitude of 42° 33′ 30″ N. longitude by estimation 4h. 43′ 32″ W. from Greenwich, the beginning of the total eclipse of June, 1806, was observed at 15d. 22h. 6′ 18″.1, and the end at the 16d. 0h. 50′ 34″.6, apparent time, by astronomical computation. Required the longitude of the place of observation?

Most of the following elements are calculated in Problems I. II. IV. V.

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* When the horary motion varies, it must be taken to correspond to the middle time between the beginning of the eclipse, and the conjunction or new moon.

† When the eclipse or occultation is nearly central or (in other words) when FD, EL are very small in comparison of SF, the latitude thus found cannot be depended on, as a small error in the times of observation, would produce a considerable error in the latitude. Indeed the case may occur when FD, EL are less than 30″, that it may be uncertain whether the points F, L, fall above or below the line DE. because the error of the lunar tables in latitude may sometimes be equal to 30″. In this case the correct latitude of the moon may be found (1) By observations made at another place where the eclipse or occultation was not so central. (2) By the number of digits eclipsed, if it was a solar eclipse. (3) By the difference of declinations of the moon and star observed before and after the immersion or emersion. (4) By the meridian altitude of the moon observed the same day, whence it may be found whether the moon was north or south of her place given by the tables.

ELEMENTS OF THE ECLIPSE.	BEGINNING.	END.
	d. h. ′ ″	d. h. ′ ″
Apparent times of observation	15 22 6 18.1	16 0 50 34.6
Estimated longitude W. from Greenwich	4 43 32	4 48 32
Supposed time at Greenwich	16 2 49 50.1	16 5 34 6.6
☉'s right ascension	5 36 50.0	5 37 18.5
Lat. of place 42° 33′ 30″—Reduc. Tab. XXXVIII. 11′ 26″	42 22 4	
Obliquity of the ecliptic	23 27 48	° ′ ″
☽'s long. by N. A.—Err. Tab. 58″.5=True long. ☽ Prob. I.	83 40 3.5	85 29 32.6
Longitude of the Nonagesimal, by Prob. IV.	63 22 31	95 26 36
☽'s true long.—Long. Nonages= ☽'s dist. from Nonages	20 26 32	350 2 57
This distance or supp. if greater than 180° is arch D.	D 20 26 32	D 9 57 3
Altitude of Nonagesimal Prob. IV.	67 58 30	70 57 46
☽'s horizontal parallax, by Prob. I.	60 24.1	60 27.0
—☉'s hor. par. 8″.8—Correction, Table XXXVIII. 5″.6	— 14.4	— 14.4
Reduced parallax	60 9.7	60 12.6
☽'s S. Diam. by N. A.—Inflexion 2″	16 26.7	16 26.4
Add correction Table XLIV.	15.2	16.4
☽'s corrected semi-diameter	16 40.9	16 42.8
☉'s semi-diameter by N. A. 15′ 46″.1—Irradiation 3″.5	15 42.6	15 42.6
Sum of the corrected semi-diameters	SF= 32 23.5	SL= 32 25.4
☽'s horary motion in longitude by Problem II. Ex. II.	36 39.2	36 42.8
☉'s horary motion	2 23.1	2 23.1
☽'s horary motion from the sun*	34 16.1	34 10.7
☽'s parallax in longitude P	19 46.8	10 0.0
☽'s apparent longitude—Error Tab. 58″.5, by Prob. V.	84 8 50.3	85 19 32.6
☉'s longitude by Problem I.	84 41 3.4	84 47 35.5
Diff. ☽'s app. longitudes=☽ app. mot.		1 10 42.3
Diff. ☉'s longitudes=☉ app. mot.		6 32.1
Difference of motions of ☉ ☽		FA 64 10.2
☽'s true lat. by N. A. Prob. I.—Error Tab. 11″.4	— 24 27.4	— 15 10.4
☽'s app. lat. cor. for error Tab. 11″.4 by Prob. V.	FD=— 1 55.8	EL=+ 4 32.5
☽'s *lat. at end—Lat. at beginning*		AL=+ 6 28.3

As the apparent latitude at the beginning of the eclipse is north, and at the end south, the point F corresponding to this example falls above DE, the point L below it. The rest of the calculation is as follows.

FA 64′ 10″.2=3850″.2 log. 13.58548			3.58548
AL 6 28.3 = 388.3 log. 2.58917			
Inclination 84° 14′ tan.	10.99631	co-s.	10.00220
Apparent motion FL	3869. 7	log.	3.58768
Its arith. comp.			6.41232
SF + SL = 64′ 48″.9	3888 9	log.	3.58988
Diff. SF, SL	1 9	log.	0.27875
Diff. segments	1 91	log.	0.28090
Its half	0 95		
Half of FL	1934 85		
Sum is great segment	1935 8		
Diff. is lesser seg. FB	1933 9	log.	13.28644
SF 32′ 23″.5=	1943 5	log.	3.28858
Angle FSB	84° 19′	sine	9.99786
Inclination	84 14		
Diff. cent. ang. DSF	0 5	co-sin.	10.00000
SF		log.	3.28858
SD=32′ 23″.5 =	1943 5	log.	3.28858

☉'s longitude	84° 41′ 3″.4	
SD	— 32 23 .5	
☽'s app. long.	84 8 39 .9 by obs.	
☽'s par. long.	— 19 46 .3	
☽'s true long.	83 42 53 .1	
☉'s long.	84 41 3 .4 const.	3.55630
Diff. 3130″ .3	= 52 10 3 log.	3.49558
☽ hor. mot. fr ☉ 34′ 17″.1= 2057″.1 AC		6.68675
Time fr. conj. 1h. 31′18″.1=5478″.1 log.		3.73863
App. ti. obs.	15 22 6 18.1	
An. ti. conj.	15 23 37 36.2 at Salem	
Conjunct.	16 4 19 at Greenwich	
Diff. Merid.	4 41 23.8	
....	sine	7.16270
....	sine	3.28858
App. lat. FD=2″.8	log.	0.45128

In finding the time of conjunction or new moon, at Greenwich, 4h. 19′, in the Nautical Almanac, the longitude of the moon was supposed to be given correctly by the tables. If the calculation be made by Problem III. after allowing for the error—58″.5, the result will be 4h. 20′ 47″, whence the difference of Meridians=4h. 43′ 10″.8, which differs so little from the assumed longitude 4h. 43′ 32″, that it will not be necessary to repeat the operation. If the eclipse was observed at Greenwich, the time of conjunction ought to be determined thereby, in a similar manner to the above calculations; or by those of Problem VIII. if only one of the phases is observed: by this means the errors of the tables will be wholly avoided. If the eclipse was not observed at Green-

* This horary motion increases from 34′ 16″.1 to 34′ 19″.7 or 3″.6, during the eclipse 2h 44 16″.5, which is 1″.32 per hour. Now the ecliptic conjunction, or time of new moon at Greenwich by the N. A. was 4h. 19′ or rather 4h. 20′ 47″, corresponding to 23h. 37′ 15″ at Salem, which is 1h. 30′ 57″ after the beginning of the eclipse: and the increase of the horary motion in half that time is 1″, which added to 34′ 16″.1, gives the horary motion 34′ 17″.1, corresponding to the middle time between the beginning of the eclipse and conjunction. This is used in calculating the correct time of conjunction.

wich, the observations at any other place whose longitude is known might be made use of, and thus the difference of meridians accurately obtained.

The moon's true longitude deduced from the above observation, is 83° 48′ 53″.1; by the N. A. it is 83° 50′ 2″.0, the difference—68″.9 would be the error of the tables by this observation, if the assumed longitude 4h. 43′ 32″ and the solar tables were correct. By repeating the operation with the assumed longitude 4h. 43′ 10″.8 the error 68″.9 would be reduced to nearly the estimated value 58″.5.

The eclipse was so nearly central at Salem, that a variation of a minute in the moon's latitude, would hardly alter the times, or duration of the eclipse, so that the latitude could not be determined by the above observations to any considerable degree of accuracy. From this cause it happens that the app. latitude at the beginning of the eclipse is by the above calculation 2″.8 instead of 1′ 53″.8, as found by allowing the error 11″.4, deduced from other observations made where the eclipse was not so nearly central, and by the limits of the shadow of total darkness.

PROBLEM VII.

Given the latitude of the place, and the apparent times of the beginning and end of an occultation of a fixed star by the moon, to find the longitude of the place of observation.

In the following rule reference will be made to fig. 13, Plate XII. in which DSE represents a parallel to the ecliptic passing through the place of the star S; SF, SL the corrected semi-diameters of the moon at the beginning and end of the occultation; DF, EL the differences between the apparent latitudes of the moon and the star, when of the same name, or their sums when of different names; either of these lines falling *below* DE if the moon's apparent latitude is more southerly than that of the star, otherwise above.

RULE.

To the apparent times of the beginning and end of the occultation add the estimated longitude of the place in time if it is *west*, but subtract if *east;* the sum or difference will be the supposed time at Greenwich, corresponding to which, in the Nautical Almanac, find by Problem I. the moon's semi-diameter, horizontal parallax, longitude and latitude,* and the sun's right ascension; also the moon's horary motion by Problem II. and the true longitude and latitude of the fixed star, by Table XXXVII. corrected for aberration and equation of equinoxes by Tables XL. XLI. Find also in the N. A. the obliquity of the ecliptic. To the moon's semi-diameter, add the correction in Table XLIV.† and from the sum subtract the inflection 2″, the remainder will be her *corrected* semi-diameter. With these elements and the apparent times at the place of observation, calculate the altitudes and longitudes of the Nonagesimal, by Problem IV. and the parallaxes in longitude and latitude, and the moon's apparent longitudes and latitudes by Problem V.

Take the difference between the *apparent* longitudes of the moon at the beginning and end of the occultation, which will be the moon's *apparent* motion in longitude, the logarithm of which, in seconds, being added to the log. co-sine of the *mean*‡ of the apparent latitudes of the moon at the beginning and end of the occultation, rejecting 10 in the index, will be the logarithm of the motion of the moon on the parallel FA. The relative motion in latitude AL, is found by taking the difference of the moon's *apparent* latitudes at the beginning and end of the eclipse if they are both north or both south; but their sum if one be north and the other south. From the logarithm of FA, increasing the index by 10, subtract the logarithm of AL, the remainder will be the log. tangent of the *angle of inclination* DSB; this angle is to be taken *greater* than 90° when the difference of the moon's and star's apparent latitudes at the beginning of the occultation FD is *greater* than at the end EL, otherwise less.§ Then to the log. co-secant of the angle of inclination, add the logarithm of the relative motion FA, the sum, rejecting 10 in the index, will be the logarithm of the apparent motion of the moon in her orbit FL.

Then in the triangle SFL, the sides SF, FL (representing the corrected semi-diameters of the moon at the immersion and emersion,) and the relative motion FL are given to find the angle FSB (by Case VI. Oblique Trig.) Thus: to the log. ar. co. of FL, add the log. of the sum of SF and SL, and the log. of their difference, the

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* Corrected for the errors of the tables in longitude and latitude, when known.

† This correction must be found after the altitude and longitude of the nonagesimal are calculated.

‡ The mean latitude is half the sum of the two latitudes, if they are of the same name, but their half difference, if of different names. In solar eclipses, the correction for the *mean* latitude of the moon is neglected as too small to be taken notice of, the distance FA being taken equal to the difference of longitude DE (fig. 12. P. XII.)

§ This rule is equally true whether the points F, L fall on the same or on different sides of the line DE. If DF, EL are equal, and the points F, L fall on the same side of DE, the angle DSB will be 90°. If they are equal and those points fall on different sides of the line DE, the angle DSB may be taken acute or obtuse. In strictness when the points F, L fall on different sides of DE, the angle DSB is greater or less than 90°, according as the quantity $\frac{FD}{SF}$ is greater or less than $\frac{EL}{SL}$

sum, rejecting 10 in the index, will be the log. of the difference of the segments FB, BL; half of which added to, and subtracted from half of FL, will give the two segments FB, BL, the greater segment being contiguous to the greater side, whether SF or SL. Then from the logarithm of the segment FB, increasing its index by 10, subtract the logarithm of SF, the remainder will be the log. sine of the angle FSB,‖ which is always less than 90°. The *difference* between this and the angle of inclination DSB, will be the *central angle* DSF.

To the log. co-sine of the central angle, add the logarithm of the moon's *corrected* semi-diameter at the immersion SF, and the log. secant of the star's latitude, the sum, rejecting 20 in the index, will be the logarithm of the apparent difference of longitude of the moon and star at that time. This is to be *subtracted* from the true longitude of the star, if the central angle is less than 90°, but added, if greater than 90°, the sum or difference will be the moon's *apparent* longitude; to this must be *added* the moon's parallax in longitude, when her distance from the Nonagesimal (found as in Problem V. by subtracting the longitude of the Nonagesimal from the moon's longitude, borrowing 360° when necessary) is *greater* than 180°, otherwise the parallax must be *subtracted*; the sum or difference will be the moon's *true longitude* at the beginning of the occultation.

Take the difference in seconds between the true longitudes of the star and moon at the beginning of the occultation, to the logarithm of which, add the arithmetical comp. log. of the moon's horary motion† in seconds, and the constant logarithm 3.55630, the sum, rejecting 10 in the index, will be the logarithm of the time from the conjunction in seconds, which is to be *added* to the observed apparent time of the beginning of the occultation, when the star's longitude is greater than the moon's true longitude at that time, otherwise *subtracted*; the sum, or difference, will be the apparent time of the true ecliptic conjunction of the star and moon at the place of observation. The difference between this and the time of conjunction, inferred from the Nautical Almanac by Problem III. for the meridian of Greenwich, will be the longitude of the place. If corresponding observations be made at different places, it will be much more accurate to deduce from them the time of conjunction at each place, and take the difference of those times for the difference of meridians, if it does not differ much from the supposed difference of longitude. If there is considerable difference, the operation must be repeated, making use of the longitude found by this operation; and thus by successive operations the true longitude may be obtained.

The long. of the place of observation being accurately known, the errors of the lunar tables in lat. and long. may be easily found. For the difference between the moon's *true* longitude, deduced from the observations by the above method, and the longitude found from the Nautical Almanac, will be the error of the tables in longitude. To find the error in latitude proceed thus: To the log. sine of the *central* angle DSF, add the logarithm of the corrected semi-diameter of the moon at the immersion SF, the sum, rejecting 10 in the index, will be the logarithm of the apparent difference of latitude of the moon and star, which added to the true latitude of the star, with the sign + if the point F falls *below* the line DE, but with the sign — if *above*, will give the apparent latitude of the moon at that time, the difference between this and the apparent latitude found by Problem V. will be the error of the tables, always supposing the sign + to be prefixed to *southern* latitudes, the sign — to *northern*, and noting the signs as in algebra.*

REMARK.

In the two preceding Problems the time of the true conjunction is calculated by means of the triangle SFD, but it will be useful for the purpose of verification, to go over the calculation by means of the triangle SLE. The process is nearly the same in both methods. The differences consist in finding the angle LSB by subtracting the logarithm of SL from the logarithm of LB, increasing its index by 10, the remainder will be the log. sine of the acute angle LSB, which, *added* to the angle of inclination, (found as before) will give the *central angle* DSL, with which and the distance SL, corresponding to the end of the eclipse or occultation, may be found the apparent diff. of longitude between the sun and moon, and moon and star; this is to be added to the longitude of the sun or star at that time, if the central angle exceed 90°, otherwise subtracted, the sum or difference will be the apparent longitude of the moon corresponding, from which the time of the ecliptic conjunction may be obtained as before. If the central angle exceed 180° the sine and co-sine of the excess of that angle above 180° must be found instead of the sine and co-sine of the central angle.

The apparent latitude of the moon is found as in the preceding rules, by making use of the central angle DSL and the value SL, corresponding to the end of the eclipse or occultation; whence may be deduced the apparent latitude and the error of the tables in latitude.

It is evident that both these methods ought to give the same results and thus furnish a proof of the correctness of the calculations. All these calculations may be made by proportional logarithms, by reading in the rule, log. co-tang. for log. tang. log. co-secant for log. sine, &c. as was mentioned at the end of the rule in Problem V. and by using the constant log. 0.4771 instead of 3.55630.

‖ When SF=SL the angle may be found as in the note, with this mark in page 583.

† When this varies, it must be taken to correspond to the middle time between the immersion and true conjunction.

* See note with this mark in page 584.

TAB.

EXAMPLE.

Suppose in a place in the latitude of 20° 0' N. longitude 1h. 9m. 0s. east of Greenwich by estimation, the occultation of Spica by the Moon on Dec. 12, 1808, was observed; the immersion at 16h. 57' 29", emersion at 18h. 10' 29", apparent time by astronomical computation. Required the longitude of the place of observation?

Most of the elements in the following Table are calculated by Problems I. II. and VI.

ELEMENTS OF THE OCCULTATION.	IMMERSION	EMERSION.
	d. h. ' "	d. h. ' "
Apparent times of observation	12 16 57 29	12 18 10 23
Estimated longitude E. from Greenwich	1 9 0	1 9° 0
Supposed time at Greenwich	12 15 48 29	12 17 1 23
☉'s right ascension	17 20 59.0	17 21 12.5
Lat. of place 20° 0'—Reduc. Tab. XXXVIII. 7' 22"	19°52' 38"	° ' "
Obliquity of the ecliptic	23 27 39	
☽'s long. by N. A.—Prob. I.	200 7 56.3	200 51 36.1
Longitude of the Nonagesimal, by Prob. IV.	149 15 55	165 28 58
☽'s long.—Long. Nonages= ☽'s dist. from Nonages	50 52 1	35 22 38
This distance or its supp. to 360° is arch D.	D 50 52 1	D 35 22 38
Altitude of Nonagesimal Prob. IV.	81 17 32	74 35 18
☽'s horizontal parallax	59 52.3	59 54.4
—Reduction, Table XXXVIII.	1.4	1.4
Reduced parallax	59 50.9	59 53.0
☽'s S. Diam. by N. A.—Inflexion 2"	16 16.9	16 17.5
Add correction Table XLIV.	10.4	13.3
☽'s corrected semi-diameter	SF 16 27.3	SL 16 30.8
☽'s horary motion in longitude by Problem II. Ex. I*.	35 51.7	35 54 2
☽'s parallax in longitude	46 25	33 54
☽'s apparent longitude	200 54 21.3	201 25 30.1
Difference of ☽'s app. longitudes		31 8.8
☽'s true lat. by N. A. Prob. I. South	1 55 11.0	1 51 29.1
☽'s parallax in latitude	10 23.6	17 38.4
☽'s apparent latitude South	2 5 34.6	2 9 7.5
*'s tr. lat.= lat. T. XXXVII. 2° 2' 13".9. S.—T. XLI. 0".6	2 2 13.3	2 2 13.3
Difference ☽ * app. lat.	FD= 3 21.3	EL= 6 54.2
Difference of ☽'s app. latitudes		AL= 3 32.9
*'s tr. long.=Long. Tab. XXXVII. 201° 10' 29".3+Tab. XL. 11".5—Tab. XLI. 10".1.	201 10 30.7	

' The difference of the apparent latitudes of the Moon and Star at the beginning of the occultation 3' 21".3 being less than at the end 6' 54".2 the angle of inclination is less than 90°. In this example the moon's latitude is more southerly than the star's, hence the points F, L, fall below the line DE.

Diff. app. long. ☽	31' 8" 8=1868".8	log.	3.27156			
☽'s mean app. lat.	2 7 21	cos.	9.99970			
Distance FA		log.	13.27126			3.27126
☽'s diff. lat.	AL=3 32.9=212 .9	log.	2.32818			
Inclination	83° 30'	tan.	10.94308		co-secant	10.00280
Apparent motion FL	1879 .6					3.27406
Its arith. comp.			6.72594			
SF + SL	= 32 58.1 = 1978 .1	log.	3.29625			
Diff. SF, SL	3 .5	log.	0.54407			
Diff. segments	3 .7	log.	0.56626			
Its half	1 .2					
Half FL	939 .8					
FB	938 .0	log.	2.97220			
SF	987 .3	log.	2.99445			
FSB	71° 49'	sine	9.97775			
Inclination	83 30					
Diff. is cent. angle	11 41	co-sine	9.99091		sine	9.30[illegible]
SF		log.	2.99445			2.99445
Star's lat.	2° 2' 13"	sec.	10.00027			
				FD 199".9=	3' 19".9 lon.	2.300[illegible]
Diff. app. long. ☽ * 967".5 =	16 7.5	log.	2.98563			
* longitude	201 10 30.7			* lat.	2 2 13 .3	
☽'s app. long.	200 54 23.2	by obs.		☽'s ap. lat.	2 5 33 .2 by obs.	
☽'s par. long.	— 46 25			☽'s ap. lat.	2 5 34 .6 by N. A.	
☽'s true long.	200 7 58.2	const.	3.55630	Error Tab.	— 1 .4 in lat.	
Diff. true long.	3752.5= 1 2 32.5	log.	3.57432	☽'s tr. lon.	200 7 58 .2 by obs.	
☽'s hor. mot.	2153.5 35 53.5	log.co-ar.	6.66686	☽'s tr. lon.	200 7 56 .3 by N. A.	
Time	6273 1 44 33	log.	3.79748	Error Tab.	+ 1 .9 in long.	
Immersion	16 57 29					
Conjunction	18 42 2	at place of observa-				
Conjunction	17 33 0	tion at Greenwich.				
Diff. of meridians	1 9 2					

* The moon's horary motion varies from 35' 51".7 to 35' 54".2 during the occultation, hence at the middle time 17h. 49' 45" between the immersion 16h. 57' 29" and the conjunction 18h. 42' (deduced from the Nautical Almanac) the horary motion was 35' 53".5 as is easily found by a calculation similar to that in the Example of Problem VI.

The difference of meridians deduced from the observation 1h. 9′ 2″ differs but 2″ from the assumed quantity 1h. 9′ 0″. If the difference had been considerable, it would have been necessary to repeat the operation with the difference of meridians thus calculated, and so on till the assumed and calculated longitudes agree. The errors of the tables above found were deduced upon the supposition that the observations were actually made at the place mentioned in this example, and that the true longitude of the place of observation was 1h. 9′ 0″. For it must be observed, that the errors of the tables in longitude cannot be found by an observation of an eclipse or occultation without knowing by other observations the precise longitude of the place of observation. This is evident by observing, that by repeating the operation till the assumed and calculated longitude of the place of observation agree with each other, the long. of the moon, deduced from the calculation, will agree also with the longitude by the tables. The time of conjunction at Greenwich 17h. 33′ 0″ taken from the Nautical Almanac, is liable to a small error from the incorrectness of the tables. To obviate this error it will be necessary to deduce (by the above method or by Problem IX. when only the beginning or end is observed) the time of conjunction from observations actually made at two places, the difference of these times will be the difference of meridians free from the errors of the tables.

PROBLEM VIII.

To find the longitude of a place by an eclipse of the sun when the beginning or end only is observed, the apparent time being estimated from noon to noon, according to the method of astronomers; the latitude of the place being also known.

RULE.

To the apparent time apply the estimated longitude of the place in time, by adding if *west*, subtracting if *east*, the sum or difference will be the supposed time at Greenwich. Corresponding to this time in the Nautical Almanac, find by Problem I. the moon's semi-diameter, horizontal parallax, longitude, and latitude; * and the sun's semi-diameter, longitude, and right ascension; also the moon's horary motion from the sun by Problem II. Decrease the sun's semi-diameter 3½″ for *irradiation*. Decrease the moon's semi-diameter 2″ for *inflexion*, and to the remainder add the correction in Table XLIV. † the sum will be the moon's *corrected* semi-diameter. Find, also, in the Nautical Almanac, the obliquity of the ecliptic.

With these elements and the apparent time at the place of observation, calculate the altitude and longitude of the nonagesimal by Problem IV. and the parallaxes in longitude and latitude and the moon's apparent latitude by Problem V.

To the sum of the corrected semi-diameters of the sun and moon *add* and *subtract* the moon's apparent latitude, and find the logarithms of the *sum* and *difference* in seconds. Half the sum of these two logarithms will be the logarithm ‡ of an arch in seconds, to be added to the sun's longitude if the phase is after the apparent conjunction, but subtracted if before; § the sum or difference will be the *apparent* longitude of the moon. To this add the moon's parallax in longitude when the moon's distance from the nonagesimal (found as in Problem VI. by subtracting the longitude of the nonagesimal from the moon's longitude, borrowing 360° when necessary) is greater than 180°, otherwise subtracted, the sum or difference will be the *true* longitude of the moon.

Take the difference in seconds between the true longitudes of the sun and moon, and to its logarithm add the arithmetical complement log. of the moon's horary motion from the sun in seconds, and the constant logarithm 3.55630, the sum, rejecting 10 in the index, will be the logarithm ‡ of the correction of the given time expressed in seconds. This is to be added to the apparent time of observation when the moon's true longitude is less than the sun's, otherwise subtracted; the sum or difference will be the time of the true conjunction at the place of observation. The difference between this and the time of conjunction inferred from the Nautical Almanac for the meridian of Greenwich by Problem III. will be the longitude of the place of observation in time, supposing the lunar and solar tables to be correct; but it is much more accurate to compare actual observations made at different places, by deducing the times of the ecliptic conjunction from each observation, the difference of these times will be the difference of longitude.

EXAMPLE.

At Salem, in the latitude of 42° 33′ 30″ N. longitude by estimation 4h. 43′ 32″ W. from Greenwich, the beginning of the total eclipse of June, 1806, was observed at 15d. 22h. 6′ 18″.1 apparent time by astronomical computation Required the longitude of the place from this observation?

The elements must be calculated as in the example of Problem VI. for the beginning of the eclipse, except those marked in italics. The rest of the calculation may be made by proportional logarithms as follows:

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* The longitude and latitude must be corrected for the errors of the tables, when known, by a previous operation, or by other observations.

† This correction must be found after the altitude and longitude of the nonagesimal are calculated.

‡ These calculations may be made in the same manner by using proportional logarithms, the only difference consists in using the constant logarithm 0.4771 instead of 3.55630 in finding the time of conjunction.

§ In general, the beginning of an eclipse or occultation precedes the apparent conjunction, and the end is after the apparent conjunction, but there is a case (which very rarely occurs) where the contrary may take place: namely, where the point F or L, (P. XII. fig. 12, 13,) falls between C and B, which can happen only when the lines FD, EL are nearly equal to SF or SL. In this case it may be ascertained whether the phase precedes or follows the conjunction by making the calculation as in Prob. VI. or VII. with the times of beginning and end, calculated by Problem XIII. and as the central angle is greater or less than 90°, the phase will follow or precede the apparent conjunction. The latitudes given by the tables being supposed correct.

Sum semi-diam. ☉ ☽	32′ 23″.5		
☽ App. lat.	1 55 .8		
Sum	34 19 .3	P. L.	0.7197
Diff.	30 27 .7	P. L.	0.7715
		Sum	1.4912
Half sum	Arch 32 20	P. L	7456
☉ Longitude	84 41 3 .4		
☽ App. long.	84 8 43 .4		
☽ Par. long.	— 19 46 .8		
☽ True long.	83 48 56 .6		
☉ True long.	84 41 3 .4	Cons. log.	0.4771
Difference	52 6 .8	P. L.	0.5383
☽ Hor. mot. fr. ☉	31 17 .1	A Co. P. L.	9.2798
Time from conj.	1h. 31′ 15″	P. L.	0.2952
App. time obs.	15 22 6 18		
App. conj. Salem	15 23 37 31		
App. conj. Green.	16 4 19 by N. A.		
Diff. Merid.	4 41 29		

If we suppose the time of conjunction at Greenwich to be 4h. 20′ 47″, as calculated in the example Problem VI. the difference of meridians would be 4h. 43′ 16″, agreeing nearly with the assumed longitude, so that it will not be necessary to repeat the operation. The remarks at the end of that example, respecting the errors of the lunar tables, and the comparing of actual observations at different places, are equally applicable to the present Problem.

PROBLEM IX.

To find the longitude of a place by an occultation of a fixed star by the moon, when the immersion or emersion only is observed, the apparent time being estimated from noon to noon, according to the method of astronomers, and the latitude of the place being known.

RULE.

To the apparent time apply the estimated longitude of the place turned into time, by adding if *west*, subtracting if *east*, the sum or difference will be the supposed time at Greenwich. At this time find in the Nautical Almanac the sun's right ascension, the moon's semi-diameter, horizontal parallax, longitude and latitude * by Problem I. and the moon's horary motion by Problem II. also the latitude and longitude of the fixed star by Table XXXVII. and correct it for aberration and equation of equinoxes by Tables XL. XLI. Decrease the moon's semi-diameter 2″ for inflexion, and to the remainder add the augmentation from Table XLIV. † the sum will be the *corrected* semi-diameter. Find also, in the Nautical Almanac, the obliquity of the ecliptic. With these elements and the apparent time of observation, calculate the altitude and longitude of the Nonagesimal by Problem IV. also the parallaxes in longitude and latitude of the moon's apparent latitude by Problem V.

Take the difference between the latitude of the star and the app. lat. of the moon, which add to, and subtract from the moon's corrected semi-diameter (these quantities being expressed in seconds) half the sum of the logarithms of these quantities increased by the log. secant of the star's latitude, rejecting 10 in the index, will be the logarithm ‡ of an arch in seconds to be added to the star's longitude if the moon has passed the apparent conjunction, but subtracted if *before*, § the sum or difference will be the *apparent* longitude of the moon. To this add the moon's parallax in longitude when the moon's distance from the nonagesimal (found as in Problem VII. by subtracting the longitude of the nonagesimal from the moon's longitude, borrowing 360° when necessary) is greater than 180°, otherwise subtract it, the sum or difference will be the *true* longitude of the moon. Take the difference in seconds between the moon and star's true longitudes, and to its logarithm add the arithmetical comp. log. of the moon's horary motion and the constant logarithm 3.55630, the sum, rejecting 10 in the index, will be the logarithm ‡ of a correction in seconds to be applied to the given time of observation by *adding* when the moon's true longitude is less than the star's, otherwise *subtracting*, the sum or difference will be the time of the true conjunction at the place of observation. The difference between this and the time of conjunction inferred from the Nautical Almanac by Problem III. for the meridian of Greenwich, will be the longitude of the place of observation, if the tables are correct; but it is much more accurate to compare the times of conjunction deduced

* Corrected for the errors of the tables in longitude or latitude when known.

† This correction must be found after the altitude and longitude of the nonagesimal are calculated.

§ See note with this mark in page 589.

‡ Proportional logarithms may be used instead of common logarithms, the constant logarithm being 0,4771 instead of 3,55630, and the log. co-sine being used instead of log. secant.

from actual observations at the different places in the manner mentioned at the end of the rule given in Problem VII.

EXAMPLE.

Suppose in a place in the latitude of 20° 0′ N. longitude by estimation 1h. 9′ 0″ east from Greenwich, the emersion of the star Spica was observed on December 12, 1808, at 18h. 10′ 29″, apparent time by astronomical computation. Required the longitude of the place of observation?

The elements must be calculated as in the example of Problem VII. for the emersion of Spica. The rest of the calculation, made by common logarithms, is as follows.

☽ Semi-diameter	16′ 30″.8 = 990″.8				
Diff. app. lat. ☽ ✱	6 54 .2 414 .2				
Sum	1405 .0	log. 3.14768			
Difference	576 .6	log. 2.76087			
Sum		5.90855	its half		2.95427
			✱ lat. 2° 2′ 13″.	sec.	10.00027
Arch	15′ 0″.6	=	900″.6	log.	2.95454
✱ longitude	201 10 30 .7				
☽ app. long.	201 25 31 .3				
☽ par. long.	— 33 54				
☽ true long.	200 51 37 .3		Constant	3.55630	
Diff. true long. ☽ ✱	18 53 .4 = 1133.4		log.	3.05438	
☽ horary motion	35 54 .7 = 2154.7		co. log.	6.66661	
Time	31 34 = 1894		log.	3.27729	
Time of obs.	18 10 29				
Conj. at place obs.	18 42 3	by obs.			
Conj. at Greenwich	17 33 0	by N. A.			
Difference merid.	1 9 3				

The difference of meridians by calculation 1h. 9′ 3″ differs but 3″ from the assumed longitude, so that it will not be necessary to repeat the operation. All the remarks made at the end of the example in Problem VII. are applicable to this problem. It may also be further observed, that the emersion or immersion which happens on the dark limb of the moon can be observed with much more accuracy than on the enlightened limb; because the light from this limb prevents the observer from perceiving the star's immersion or emersion so instantaneously as on the dark side of the moon.

PROBLEM X.

To calculate an eclipse of the moon.

The time of beginning or end of a lunar eclipse at any place may be found by subtracting or adding the longitude to the times given in the Nautical Almanac for the meridian of Greenwich, according as the longitude is west or east. But as some readers may wish to know the method of deducing these times from the longitudes, latitudes, &c. of the moon and sun, given by the Nautical Almanac or by other tables, it was thought proper to insert the rule for these calculations.

An eclipse of the moon can only happen at the time of the full moon. If her longitude at that time is not distant from either node* of the moon's orbit more than about 12°, there may be an eclipse. To find whether there will be one, and to calculate the times and phases, proceed as follows.

RULE.

Find the time of full moon at Greenwich by the Nautical Almanac or Problem III. to which *add* the longitude of the place turned into time if *east*, but *subtract* if *west*, the sum or difference will be the time of the ecliptic opposition at the proposed place.

For the time at Greenwich find by Problem I. the moon's latitude, horizontal parallax and semi-diameter (which requires no augmentation) also the sun's semi-diameter. Then by Problem II. the horary motion of the moon from the sun in longitude, and the moon's horary motion in latitude.

Draw the line ACB (Plate XII. fig. 6) and perpendicularly thereto the line PCR. Select a scale of equal parts to measure the lines of projection, and from it take CG equal to the moon's latitude, and set it on CR from C to G, *above* the line AB if the latitude of the moon is *north*, below if south.† Take CO equal to the horary motion of the moon from the sun in longitude, and set it on the line CB to the right of

* The longitude of the moon's ascending node is given in the third page of the Nautical Almanac. The longitude of the other node is found by adding or subtracting 6 signs.

† The northern latitudes found by Prob. I. have the sign —, the southern +. In the figure the latitude is south. If it had been north the point G must have been placed on the continuation of RC above C.

C, from C to O. Take CP equal to the moon's horary motion in latitude, as found with its sign by Problem II. and set it on the line CR from C to P, *above* the line AB if its sign is —, *below** if +. Join OP which is equal to the horary motion of the moon from the sun, and parallel thereto through G draw the relative orbit of the moon from the sun NGL, on which are to be marked the places of the moon before and after the full, by means of the horary motion OP, so that the moment of full moon, or ecliptic opposition at the proposed place, may fall exactly on the point G. This may be done by making the extent OP equal to the transverse distance of 60, 60, on the line of lines of the sector, then measuring from the same lines the transverse distance corresponding to the minutes and parts of a minute in the time of full moon at the place of observation, and setting it on the line GN from G towards the right to the point x, where the whole hour preceding the full moon is to be marked.† Then the distance OP set from x to the right hand on the line LGN reaches to the hours preceding the full moon, and set to the left hand reaches successively to the following hours. These intervals are to be divided into sixty equal parts representing minutes, if the size of the scale will admit of it.

Add 50″ to the moon's horizontal parallax‡ and from the sum subtract the sun's semi-diameter, the remainder will be the semi-diameter of the shadow CB, with which describe the circle ASB about the centre C. Add the moon's semi-diameter to the radius CB, and with that radius describe, about the centre C, the circle DRM, which if there be an eclipse will cut NL in the points E, H, representing respectively the places of the moon at the beginning and end of it. If there is no intersection there will be no eclipse. Draw the line CKST perpendicular to LN, cutting it in K and meeting the circles ASB, DRH in S, and T. With a radius equal to the moon's semi-diameter describe about the centres E, H, K, the small circles represented in the figure; of which that drawn round K cuts the line CKS in the points I, F, and if the eclipse is total the whole of this circle will fall within ASB, as in fig. 6, but if part of the circle falls without ASB, as in fig. 7, P. XII. the eclipse will be partial. In either case the number of digits eclipsed may be obtained by saying as the diameter of the moon FI is to the obscured part FS so are 12 digits to the number of digits eclipsed. When the eclipse is total, the beginning and end of total darkness may be found by taking a radius equal to CB decreased by the moon's semi-diameter, and sweeping with it round the centre C, a circle *d e h m*, cutting LN in the points *e*, *h*, representing respectively the points of beginning and end of total darkness. Then the hours and minutes marked in the line NL, at the points E, *e*, K, *h*, H, will represent respectively the times of the beginning of the eclipse, beginning of total darkness, middle of the eclipse, end of total darkness, and end of the eclipse. In this rule no allowance is made for the oblate figure of the earth, the correction from this source being much less than the errors of observation.

EXAMPLE.

Required the times of beginning, end, &c. of the eclipse of the moon of May 9th, 1808, at a place in the longitude of 30° W. from Greenwich?

By the Nautical Almanac the time of full moon at Greenwich was May 9th, at 19h. 39′. From this subtracting the longitude of the place of observation 30° W. or 2h. the remainder 17h. 39′ was the time of full moon at the place of observation. Corresponding to the time at Greenwich, 19h. 39′, the elements in the adjoined table were calculated by Prob. I. and II. and the values CB, CD, C*d*, found by the above rule. Upon the centre C with the radii CB, CD, C*d*, taken from a scale of equal parts, describe the circles ASB, MRD, *mrd*. Draw the line ACB representing the ecliptic, and

Elements of the Eclipse May 9, 19h. 39′					
App. time conj. Greenwich, May 9			19h.	39	
Long. place 30° W			2	0	
App. time conj. at place obs.			17	39	
☽'s lat. by Prob. I. S. decreasing	CG	+	10	44″	.8
☽'s Horiz. Paral.			61	13	.5
☽'s Semi-diameter	BD		16	40	.7
☉'s Semi-diameter			15	51	.5
☽'s Hor. Mot. in long. Prob. II.			57	37	.8
☉'s Hor. Mot. in long.			2	24	.8
☽'s Hor Mot. from ☉ in long.	CO		55	13	.0
☽'s Hor. Mot. in lat. Prob. II.	CP	—	3	28	.2
☽'s Hor. Par.+50″—☉'s S. D. =	CB		46	12	.2
CB+☽'s S. D. =	CD		62	52	.9
CB—☽'s S. D. =	C*d*		29	31	.5

* In other words the point P will fall above C if the moon is approaching to the north pole of the ecliptic, otherwise below: That is, the point P must fall *above* C if the moon's latitude is *south decreasing* or *north increasing*, otherwise below. When no great accuracy is required the horary motion in latitude need not be found by Prob. II. Instead of which the angle COP may be taken equal to 5° 40′, in eclipses of the moon or sun, and the line OP equal to CO increased by 9″ or 10″: but this method will not answer in occultations, in which the angle COP varies above 5 degrees.

† The distance Gx may also be found by common arithmetic by saying as 60 minutes are to the minutes and seconds in the time of full moon (which in the present example is 39) so is OP to Gx. After marking the hours on the line LGN it is usual to divide them successively into halves and quarters of an hour, then into five minutes and one minute.

‡ The semi-diameter of the shadow is increased by the earth's atmosphere from 20″ to 60″, according to the estimates of different astronomers. Mayer supposes this correction to be one 60th part of the shadow, varying from 37″ to 46″. The mean of Mayer's correction added to the sun's parallax is nearly equal to 50″ assumed as above.

make CG perpendicular thereto equal to the moon's latitude 10′ 44″.8 S. the point G being taken below C because that latitude is south. Make CO equal to the horary motion of the moon from the sun in longitude 35′ 13″.0, and CP perpendicular thereto equal to the horary motion in latitude—3′ 28″.2, the point P being placed above C, because the moon's horary motion in latitude has the sign — prefixed, or in other words, the latitude was south decreasing. Join OP, and parallel thereto draw through G the line NGL, and on it let fall the perpendicular CK. Make the distance OP a transverse distance of 60, 60, on the line of lines of the sector, and measure from the same lines the transverse distance 39,39 (corresponding to the minutes in the time of full moon at the place of observation) this distance, set on the line GN, to the right of G, reaches to the point x, where the hour 17h. preceding the full moon is to be marked. Take the extent OP and lay it from 17h. to the right hand to 16h. and successively to the left to 18h. 19h. &c. Subdivide these lines into 60 equal parts, representing minutes, if the scale will permit, and the times corresponding to the points E, e, K, h, H, will represent respectively the beginning of the eclipse 15h. 56m. the beginning of total darkness 16h. 54m. the middle of the eclipse 17h. 41m. the end of total darkness 18h. 28m. and the end of the eclipse 19h. 26m. which times agree nearly with those in the Nautical Almanac, allowing for the difference of meridians 2 hours.

Calculation by Logarithms.

The phases of the eclipse may also be calculated by logarithms in a very simple manner. Thus suppose it was required to find the time of the beginning of the eclipse in the above example. In this case in the right-angled triangle OCP, there would be given CO=2113″.0 and CP=208″.2, to find OP=2123″.2 and the angle OPC=84° 22′. This angle is equal to RGE, because GE, OP are parallel, and its supplement gives the angle CGE=95° 38′. Then in the triangle CGE there are given the angle CGE=95° 38′ the moon's latitude CG=644″.8, and the line CE (=CD) =3772″.9 to find CEG= 9° 48′, GCE=74° 34′ and GE=3654″.5. Then say as OP (2123″.2) is to 1 hour (3600″.) so is GE (3654″.5) to the time (6196″=) 1h. 43′ 16″ between the beginning of the eclipse and the full moon at the place of observation 17h. 39′, and as the point E falls to the right hand of G, that time must be subtracted from 17h. 39′, to obtain the time of the beginning of the eclipse 15h. 55′ 44″, which agrees nearly with the projection. As these calculations are very simple, it will be unnecessary to take notice of the different cases, or to give the calculations at full length, the whole being sufficiently evident from the figure. The middle of the eclipse is found by means of the triangle GKC similar to OCP, in which the angles and hypotenuse CG are given to find CK, KG. The time of describing KG being added to, or subtracted from the time of full moon at the place of observation, according as the point K falls to the left or right of G, will give the time of the middle of the eclipse. The distance CK 10′ 41″.7 subtracted from the radius CD or CT=62′ 52″.9 will leave a remainder equal to the eclipsed part FS (=KT) 52′ 11″.2. And the moon's diameter 33′ 21″.4 is to FS 52′ 11″.2 as 12 digits to the digits eclipsed 18¾. In making these calculations, common or proportional logarithms may be made use of.

PROBLEM XI.

To project an eclipse of the sun for any given place.

An eclipse of the sun can happen only at the time of new moon. If the moon's longitude at that time is not distant from either node of the moon's* orbit more than 17½° there may be an eclipse. To find whether there will be one, and to calculate the times and phases, proceed by the following

RULE.

To the time of the new moon given in the Nautical Almanac (or calculated by Problem III.) add the longitude of the proposed place, turned into time, if east, but subtract if west, the sum or difference will be the time of conjunction at the proposed place. Corresponding to the time of new moon at Greenwich, find by Problem I. the moon's latitude, horizontal parallax, and semi-diameter, also the sun's longitude, semi-diameter and declination. Then by Problem II. find the horary motion of the moon in latitude, and the horary motion of the moon from the sun in longitude.

Draw the line ACB (Plate XII. fig. 10.) representing the ecliptic and perpendicularly thereto, the line PCR. Take a scale of equal parts to measure the lines of the projection; measure from it an interval equal to the moon's latitude, and apply it on CR from C to G, *above* the line ACB if the moon's latitude is *north*, *below*, if *south*.† Take CO equal to the horary motion of the moon from the sun in longitude and set it on the line CB to the right hand of C to O; take CP equal to the moon's horary

* See note with this mark in page 591. All the eclipses that can happen in any part of the earth are indicated in the Nautical Almanac.

† In the figure the latitude is supposed north. If it had been as much south, the point G would have been as much below C as it is now above it.

motion in latitude, found by Prob. II. and set it on the line CR, from C to P, *above* * the line ACB if the sign is —, *below* if +. Join OP which represents the horary motion of the moon from the sun on the relative orbit, and parallel to that line draw the relative orbit of the moon NGL, on which are to be marked the places of the moon before and after the conjunction, by means of the horary motion OP, so that the moment of the new moon, or ecliptic conjunction, at the proposed place may fall exactly on the point G, as in the figure where the new moon is at 23h. 35½m. This may be done by taking the extent OP equal to the transverse distance of 60, 60, on the line of lines of the sector, then measuring from the same lines, the transverse distance corresponding to the minutes and parts of a minute of the time of new moon at the place of observation and setting it on the line GN from G towards the right hand to the point *x*, † the place of the moon at the first whole hour preceding the conjunction (which in the present figure is 23h.) Then the distance OP being taken in the compasses and set from *x* to the right hand, gives successively the hours preceding the new moon, and the same distance set to the left gives the following hours, as in the figure, where they are marked in succession 22h. 23h. 24h. 1h. These hours are to be divided into 60 equal parts representing minutes, the scale being taken sufficiently large for that purpose. ‡ In the present figure the subdivisions are carried only to five minutes.

From the moon's horizontal parallax subtract the sun's 8″.8, the remainder is to be taken from the scale of equal parts for the radius CB, with which, on the centre C, describe the circle BRA, cutting CR in R. Open the sector till the transverse distance of 60°, 60°, on the line of chords, is equal to the radius CB, and measure from the same lines the transverse distance 23° 28′ (equal to the obliquity of the ecliptic) which set on the circle ARB on each side of R to T and U. Join TU cutting CR in Q. On Q as a centre, with the radius QT, describe the circle TVU, on which set off the arch TV equal the sun's longitude. Through V draw the line VP′ parallel to CR to cut TU in P′, the place of the pole of the earth.§ Draw CP′ and continue it on either side so as to cut the circle ARB in the point W, situated *above* AB if the latitude of the proposed place is *north*, *below*, if *south*. In the present figure the latitude is north. If it had been south the lower part of the circle ARB ought to have been made use of. Open the sector so as to make the transverse distance 60°, 60°, on the chords, equal to CB, and measure off the transverse distance equal to the chord of the complement of the latitude of the place, which set from W on each side to D and *d*. With the same opening of the sector measure the chord of the sun's declination, and set it on the same circle from D on each side to E and F, and from *d* on each side to *e* and *f*. Draw the dotted lines F*f*, D*d*, E*e*, cutting CW in *l*, *q*, *n*. Bisect *ln* in *r*, and erect the line VI. *r*, XVIII. perpendicular to CW, and make *r*, VI. and *r*, XVIII, each equal to *q*D. Open the sector to make the transverse distance 90°, 90°, on the sines, equal to *q*D, and measure off the transverse distance corresponding to 15°, 30°, 45°, 60°, 75° (or 1, 2, 3, 4, 5 hours,) which set on each side of the point *r*, on *r*, VI. and *r*, XVIII. to the points marked with those numbers 15°, 30°, &c. Through these points draw the lines I. XI ; II. X ; III. IX ; &c. as in the figure parallel to CW. Open the sector so as to make *rn* equal to the transverse distance of 90°, 90°, on the sines, and measure the complements of the former degrees

* See note with this mark in page 592.

† See note with this mark in page 592.

‡ The scale I generally make use of is one inch to 10 minutes, reducing the seconds to decimals of a minute. Thus 50′ 36″ in decimals is 50′.6, which by this scale would be 5.06 inches, obtained by placing the decimal point one figure to the left.

§ This may also be found as follows. After drawing TQU, as above, open the sector till the transverse distance 90°, 90° on the sines is equal to QT, then measure from that line the extent QP′ as a transverse distance corresponding to the sine of the difference between the sun's longitude and 90° or 270°. When the sun's longitude exceeds 6 signs, the point V will fall in the semi-circle below TU. This is not drawn in the figure for want of room. When the longitude exceeds 2, 4, 6, &c. signs, it will be convenient to mark on the circle TVU the points corresponding to those signs, by setting off the radius QT as a chord from T to II, from II to ♌, &c. and then taking from the sector the chord corresponding to the excess of the given longitude above that of the point II, ♌, &c. immediately preceding. Thus if the sun's longitude was 84° 44′ it would be convenient to set off 60° from T to II, and 24° 44′ from II. to the sought point V.

In case of not having a sector, an arch as RT may be marked off by a plane scale even when the radius CR differs from that of the scale, by drawing by Prob. VI. of Geometrical Problems, the line CT making an angle with CR equal to the proposed arch 23° 28′. The intersection of that line with the circle ARB will give the sought point T. In a similar manner the point V may be found by drawing a line QV making the angle TQV equal to the proposed arch TV. The points 15°, 30°, 45°, &c. on the line VI. *r* XVIII. may be found by describing on that line as a diameter, and on *r* as a centre, a semi-circle which is to be divided into 12 equal parts of 15° each. The dotted lines drawn through these points perpendicular to the diameter VI. *r* XVIII. will cut it in the sought points 15°, 30°, &c. This circle is not drawn in the proposed figure, to prevent confusion. Draw the line VI. *k* perpendicular to *r* VI. and equal to *rn*. Join *rk* cutting the lines 75° V : 60° IV. &c. in the points 1, 2, 3, 4, 5. Make the lines 15° I : 30°, II : 45°, III. &c. respectively equal to 75°, 1 : 60°, 2 : 45°, 3 : &c. and the sought points I. II. III. &c. will be obtained. This method may be used when the line *rn* is too small to be taken from the sector. The same method may be made use of in projecting an occultation by drawing *tk* (Fig. 8. P. XII.) perpendicular to *rt* and equal to *rn* and joining *rk* to cut the dotted lines drawn parallel to CP in the points 1, 2, 3, &c. as above.

as transverse distances on the sines, viz. 75°, 60°, 45°, 30°, 15°, and set them on the above lines I. XI; II. X; &c. from the points of intersection with the line VI. *r*, XVIII. above and below that line. The points I. II. III. &c. obtained in this manner, will represent the situation of the spectator at the proposed place at those hours, and a regular curve drawn through these points will represent his path. In marking the hours it must be observed, that the place of noon will be at the *lower point n*, if the sun's declination is *north;* but at the *upper point l*, if the declination is *south;* the hours must be marked from noon towards the left in numerical succession completely round the curve ending at 24h. according to the method of astronomers. In the present figure the declination is north, and the point *n* the place of noon or 0 hours. If it had been south the point *l* would have been marked 0h. and the points marked XI. X. &c. would be I. II. &c. respectively. The path touches the circle ARB in two points representing the points of sun rising and setting, which in the present figure are respectively 16h. 26′ and 7h. 34′. These points divide the path into two parts, of which one represents the path by day, the other by night, as is evident from the hours marked on the curve. Half hours or any other intermediate time, may be marked in a similar manner. Thus, for the time 3h. 30′=52° 30′. Set the sine of 52°½ to the radius *r*, VI. from *r* to *h* on the line *r*, VI. and erect the perpendicular *hi* equal to the sine of 37°½ (which is the complement of 52°½) to the radius *rn*, and the point *i* will be the place of the spectator at the proposed time. In this way the halves and quarters of hours may be marked on those parts of the path where necessary. The smaller subdivisions may generally be obtained to a sufficient degree of accuracy by dividing the quarters of hours into equal parts.

Take from the scale of equal parts an extent equal to the sum of the semi-diameters of the sun and moon, and beginning near N, find by trials the point *p′* of the moon's path and the point Z′ of the path of the spectator, marked with the same time and at that distance apart. That time will be the beginning of the eclipse. If no such points can be found, there will be no eclipse at the proposed place. Proceed in the same way towards the point L and find the points *p″*, Z″, at the same distance apart, the corresponding time will be the end of the eclipse. Find by trials the point *p* of the moon's path and the point Z of the path of the spectator marked with the same times at the nearest distance from each other (which will in general be nearly the middle time between the beginning and end of the eclipse) that time will be the middle of the eclipse. On Z as centre with a radius equal to the sun's semi-diameter, describe the circle whose diameter is S*s*, representing the sun's disc, and on the centre *p*, with a radius equal to the moon's semi-diameter, describe the circle whose diameter is M*m*, representing the moon's disc. The part of the sun's disc that is cut off by this circle will represent the part of the sun that is eclipsed. In the example of fig. 10 the centre *p* of the moon's disc is so near that of the sun Z, that the eclipse is nearly central, and as the moon's semi-diameter is greater than the sun's, the eclipse must be *total.* Under similar circumstances if the moon's semi-diameter had been least, the eclipse could have been *annular.* In case of a partial eclipse the sun's disc will not be wholly covered by the moon, as in fig. 11, Plate XII. where the circles representing the discs of the sun and moon are marked with the same letters as in fig. 10, but the objects are placed in a different situation. In this case the number of digits eclipsed may be obtained by drawing a line through the centres *p*, Z, to meet the discs in the points S, M, *s*, *m*, and by saying as the distance S*s* (representing the whole disc) is to the obscured point M*s* so are 12 digits to the number of digits eclipsed. The beginning and end of total darkness in a total eclipse are found like the beginning and end of the eclipse, except in taking in the compasses the difference between the semi-diameters of the sun and moon, instead of their sum. For the points of the path of the spectator and of the moon's orbit, marked with the same time, and at that distance from each other, will represent the situations and times of the beginning and end of total darkness. The beginning and end of the internal contacts of an annular eclipse are found in the same manner, the only difference is that in a total eclipse, the moon's semi-diameter is greatest, but in an annular eclipse the least.

In observing the beginning of a solar eclipse, it is of some importance for the accuracy of the observation, to know on what part of the sun's limb the eclipse will begin. This is easily found by means of the projection. Thus at the beginning of the eclipse, which corresponds to the point *p′* of the moon's path and the point Z′ of the path of the spectator, the first point of contact *g* may be obtained by drawing about the centre *p′* with a radius equal to the moon's semi-diameter, a circle representing the moon's disc*; about Z′ as a centre with a radius equal to the sun's semi-diameter another circle representing the sun's disc, touching the former in the point *g*.

* Instead of this circle, the line *p′* Z′ may be drawn cutting the sun's disc in the sought point of contact *g*.

Draw the line CZ′ meeting the sun's disc in the points *a*, *c*, the point *c* being the most distant from the centre C. Then the circle *g a c* being held between the eye of the observer and the sun, the engraved or marked side of the figure towards the eye, and the line *c a* in a vertical direction with the point *c* uppermost, will represent the appearance of the sun as viewed by the naked eye at that time, *c* will represent the upper part of the sun, *a* the lower, and *g* the point of contact. If the eclipse be observed with an inverting telescope, the contrary will be observed; that is, the part *a* must be uppermost, *c* the lowest, and *g* the point of contact will appear to the left hand of *ca*. In a similar manner the appearance of the objects may be obtained at any other part of the eclipse, but it is not necessary except at the beginning of it, where there is nothing to direct the eye of the observer.

EXAMPLE.

Required the times and phases of the total eclipse of the sun, June 16, 1806, at Salem, in the latitude of 42° 33′ 30″ N. and the longitude of 4h. 43m. 32s. west from Greenwich?

By the Nautical Almanac the time of new moon at Greenwich was June 16d. 4h. 19′, corresponding to June 15, 23h. 35′ 28″, at Salem. At the time at Greenwich, 4h. 19′ the elements of the eclipse were as in the adjoined table calculated by the above rule.

ELEMENTS.			h.	m.	
Conjunction at Greenwich, June 16,			4	19	
Salem W. from Greenwich			4	43	32
Ecliptic conjunc. at Salem, June 15,			23	35	28
Latitude of Salem			42	33	30
☽'s Horizontal Parallax				60	25.7
☉'s Horizontal Parallax					8.6
☽'s Reduced Horizontal Parallax				60	16.9
☽'s Semi-diameter				16	28.1
☉'s Semi-diameter				15	46.1
Sum of Semi-diameters				32	14.2
Difference of Semi-diameters					42.0
☽'s Horary motion in Long. Prob. II.				36	41.2
☉'s Horary motion N. A.				2	23.1
☽'s Horary motion from ☉	CO			34	18.1
☽'s Horary motion in latitude	CP	+		3	22.5
☽'s Latitude by Prob. I.	CG	—		19	37
☉'s Longitude	TV		84	44	36
☉'s Declination	DF		23	22	N.

Draw ACB (Plate XII. fig. 10,) and perpendicular thereto the line CGR. Make CG equal to the moon's latitude 19′ 37″ N. taken from a scale of equal parts, the point G being above C because the latitude is north. Make CO equal to the moon's horary motion from the sun 34′ 18″.1, to the right hand of the point C; and CP equal to the moon's horary motion in latitude + 3′ 22″.5, the point P being below C because this horary motion has the sign + prefixed. Draw NGL parallel to OP. Make OP a transverse distance of 60, 60, on the line of lines of the sector, and measure from the same lines the transverse distance 35½, 35½ (corresponding nearly to the minutes in the time of new moon) this distance set on the line GN to the right of G reaches to the point *x* where the hour preceding the new moon is to be marked, viz. 23h. Take OP in the compasses and mark it successively on the line NL from *x* or 23h. to the right to 22h. and to the left to 24h. or 0h. 1h. &c. These are subdivided into five minutes, the scale not admitting smaller divisions. Take the moon's reduced horizontal parallax 60′ 16″.9 from the scale of equal parts, and with that radius describe about the centre C the circle ARB. Set off (by means of the sector) the arches RT, RU, each equal to 23° 28′. Join TQU and about that diameter describe the circle TYU. Make the arch TV equal to the sun's longitude 84° 44′ 36″, which is done by setting the radius QT as a chord from T to ♊, and then the arch ♊V=24° 44′ 36″ by means of the sector. Draw P′V parallel to CR to meet TU in the point P′. Join CP′ and continue it to meet the circle ARB in W. Make (by the sector) the arches WD, W*d*, equal the complement of the latitude of the place 47° 26½ nearly, the radius being CB. In a similar manner make the arches DF, DE, *df*, *de*, &c. each equal to the sun's declination 23° 22′. Draw the lines F*lf*, D*qd*, E*ne*, cutting CW in *l*, *q*, *n*. Bisect *ln* in *r*. Draw the line VI, *r*, XVIII parallel to D*qd* and make *r*, VI, *r*, XVIII, each equal to *q*D. Through the points *l*, VI, *n*, XVIII, *l*, draw the path of the spectator as taught in the above rule, and mark the hour of noon 0h. at the point *n* because the sun's declination is north. Mark the following hours in succession to the left I, II, III, &c. as in the figure. Take an extent in the compasses equal to the sum of the semi-diameters of the sun and moon 32′ 14″.2 and beginning towards N, find, as above directed, the points *p*′Z′ at that distance apart and marked with the same time 22h. 7′ nearly, which is the time of the beginning of the eclipse. Proceed in the same way for the end of the eclipse corresponding to the points *p*″, Z″, and to the time 0h. 53′ which is the time of the end of the eclipse. Take the difference of the semi-diameters of the sun and moon 42″ in the compasses, and proceed in the same way to find the beginning and end of total darkness 23h. 27m. and 23h. 31m. The points corresponding could not be drawn in the figure as they are so near to *p* and Z, and the scale small. Find by trials the points *p* Z marked with the same time and at the least distance apart, this will be the time of the middle of the eclipse 23h. 29′. With an extent equal to the moon's semi-diameter 16′ 28″.1 as a radius, describe about *p* the circle whose diameter is M*m*

representing the moon's disc, and with the sun's semi-diameter 15′ 46″.1, describe about Z the circle whose diameter is S s representing the sun's disc at the middle of the eclipse. The sun's disc being wholly covered by the moon, indicates that the eclipse was total. Describe in the same way about p' and Z′ the discs of the sun and moon, at the beginning of the eclipse, touching each other in g. Draw CZ′ cutting the moon's disc in c and a. Then the arch $c\ g$ will be the distance of the first point of contact of the sun and moon from the sun's zenith towards the western part of the limb.

REMARKS.

1. The correction for the spheroidal form of the earth, the augmentation of the moon's semi-diameter, inflexion and irradiation, are neglected in the above rule as not sensibly affecting the result of the projection, though these points might be attended to by the following precepts.

2. From the latitude of the place subtract the correction of latitude of Tab. XXXVIII. and from the moon's horizontal parallax decreased by 8″.8 subtract the correction of parallax in the same table; the remainders will be the corrected latitude and parallax to be made use of in the above rule to correct for the spheroidal form of the earth.

3. Decrease the moon's semi-diameter given by the N. A. by 2″ for inflexion.

4. Decrease the sun's semi-diameter 3″½ for irradiation, and from the remainder subtract a correction equal to the augmentation (Tab. XV.) that the moon's semi-diameter would have when at the same altitude as the sun, the remainder will be the corrected semi-diameter of the sun, to be used in the above rule in finding all the times and phases of the eclipse. This method of decreasing the sun's semi-diameter produces nearly the same result as that by augmenting the moon's semi-diameter, horary motion and horizontal parallax, and taking the sun's semi-diameter as given in the Nautical Almanac.

5. Besides these corrections, there are others depending on the change of the moon's semi-diameter, horizontal parallax and horary motion during the eclipse, but all these corrections are usually neglected in projecting an eclipse or occultation.

6. The altitude of the sun, which is nearly the same as that of the moon during the eclipse, may easily be found by means of the projection. Thus if it were required at the beginning of the eclipse when the spectator is at Z′: Take the distance CB and apply it as a transverse distance 90°, 90°, to the sines of the sector; then the distance CZ′ applied in the same manner to those lines, will give the zenith distance of the sun, about 31°, corresponding to the altitude 59°. The correction (Table XV.) corresponding to this altitude is 14″, which is nearly the correction to be subtracted from the sun's semi-diameter 15′, 42″.6 (corrected for irradiation) to obtain the corrected semi-diameter 15′ 28″.6, as taught in §4. Table XV. was calculated for the mean semi-diameter 15′ 37″ and the correction of the Table 14″ ought to be increased in ratio of the sun's semi-diameter 15′ 46″.1 to 15′ 37″ when very great accuracy is required. The difference of the corrected semi-diameters of the sun and moon 15′ 28″.6 and 16′ 26″.1 is 57″½, which is to be used instead of 42″ in finding the beginning and end · total rkness. The duration of the total darkness found by the corrected values 57″½ is 4¾ minutes, but with the uncorrected value 42″ is only 3¼ minutes. It was probably owing to the neglect of this correction that some of the Almanacs published in this country, for 1806, mentioned the duration as 3 minutes.

7. The path of the spectator I, II, III, IV, &c. calculated for the proposed latitude 42° 33′ 30″ may be made to answer for any other latitude by altering the centre of projection and the scale of equal parts. By this means the trouble of repeatedly describing that path, when the eclipse is to be calculated for several places, may be avoided. To do this add the Prop. Log. of the reduced parallax to the log. secant of the latitude of the place, the sum, rejecting 10 in the index, will be the Prop. Log. of an arch A. To this Prop. Log. add the log. secant of the sun's declination (or star's in an occultation) and the log. co-tangent of the latitude of the place, the sum, rejecting 20 in the index, will be the Prop. Log. of the arch B. Take the radius r, VI (or qD) in the compasses, and make it a transverse distance on the line of lines of the sector corresponding to the arch A, and with that opening of the sector measure the transverse distance corresponding to the arch B which set from r towards C on the line rC (continued if necessary) will reach to the centre of the projection corresponding to the proposed latitude; the transverse distance corresponding to the reduced parallax measured from the line of lines, with the same opening, will be the radius of the projection, and the transverse distance corresponding to the horary motion of the moon from the sun or star in an occultation, will be the horary distance to be made use of in marking the hours on the lunar orbit LN; lastly, the latitude of the moon at the conjunction is to be measured as a transverse distance, and set from the new centre of projection on a line drawn through it parallel to CR, and the point where it reaches will be the new point G corresponding to the place of the moon at the ecliptic conjunction. Through this point the line of the moon's path is to be drawn parallel to the line LN of the figure, and the hours are to be marked

on it as before. Whence the times of beginning and end of the eclipse may be found as in the above rule. An example of this method is not given, as it would render the scheme too confused.

PROBLEM XII.

To project an occultation of a fixed star by the moon, at any given place.

The method of projecting an occultation is nearly the same as that of an eclipse of the sun, but to save the trouble of reference it was thought expedient to give the rule without abridgment.

RULE.

To the time of the ecliptic conjunction of the moon and star, given in the first page of the Nautical Almanac (or calculated by Prob. III.) add the longitude of the proposed place turned into time, if east, but subtract if west, the sum or difference will be the time of conjunction at the proposed place. Corresponding to the time of conjunction at Greenwich, find by Problem I. the moon's latitude, horizontal parallax and semi-diameter, also the sun's right ascension. Then by Problem II. find the horary motion of the moon in longitude and latitude, and by Tables VIII. and XXXVII. the star's Right Ascension, Declination, Longitude and Latitude.¶

Draw the line ACB (Plate XII. fig. 8.) representing a parallel of the ecliptic passing through the star, and perpendicular thereto the line CPR. Take a scale of equal parts to measure the lines of the projection, and from it take an interval equal to the difference of the latitudes of the moon and star, and apply it to the line CR from C to G *above* the line ACB if the moon's latitude is north of the star's, otherwise *below*‡*. Take CO equal to the horary motion of the moon in longitude, and set it on the line CB to the right hand of C to O; take CP equal to the moon's horary motion in latitude found with its sign by Problem II. and set it on the line CR from C to P, *above** the line ACB, if its sign is —, below if +. Join OP which represents the horary motion of the moon on her orbit, and parallel to that line draw the orbit of the moon NGL, on which are to be marked the places of the moon before and after the conjunction by means of the horary motion OP, so that the moment of the ecliptic conjunction at the proposed place may fall exactly at the point G, as in the figure where the conjunction is at 18h. 42′. This may be done by making OP equal to the transverse distance 60, 60, on the line of lines of the sector, then measuring from the same lines the transverse distance corresponding to the minutes and parts of a minute in the time of the ecliptic conjunction at the place of observation, and setting it on the line GN from G towards the right to the point *x*, the place of the moon at the first whole hour† preceding the conjunction (which in the present figure is 18h.) Then the distance OP being taken in the compasses, and set from *x* to the right hand, gives successively the preceding hours, and the same distance set to the left gives the following hours, as in the figure, where they are marked 17h. 18h. 19h. 20h. These hours are to be divided into 60 equal parts representing minutes, the scale being taken sufficiently large for that purpose.‡ In the present figure the subdivisions are carried only to five minutes. Take the moon's horizontal parallax from the scale of equal parts for the radius CB; with which on the centre C, describe the circle BRA cutting CR in R. Open the sector till the transverse distance 60°, 60°, on the line of chords, is equal to the radius CB, and measure from that line the transverse distance 23° 28′ (equal to the obliquity of the ecliptic) which set on the circle ARB on each side of R to T and U. Join TU cutting CR in Q. On Q as a centre, with the radius QT, describe a circle TYUV, on which set off the arch TYV, equal to the star's longitude. Through V draw the line VP′ parallel to CR. Open the sector till the transverse distance 90°, 90°, on the sines, is equal to the radius CB, then take in the compasses from the same lines an extent equal to the transverse distance corresponding to the complement of the declination of the star, and with one foot in C sweep a small arch to cut the line VP′ in P′ the place of the pole of the earth.*† Draw CP′, and continue it on either side so as to cut the circle ARB in the point W situated *above* AB, if the latitude of the proposed place is *north*, but below if south. In the proposed figure the latitude is north. (If it had been south the lower part of the circle ARB ought to have been made use of.) Open the sector

¶ In strictness these quantities ought to be corrected for Aberration and Nutation by Tables XXXIX. —XLIII but the correction is so small that it may always be neglected. If the Right Ascension and Declination only are given, the latitude and longitude may be found by Problem XIX. and if the latter are given, the former may be calculated by Problem XX.

‡* In the figure the point G is placed above ACB, because the moon is in a less southern latitude than the star. This part of the rule may also be thus expressed. Find the moon's latitude with its sign as in Problem II. Prefix the sign + to the star's latitude if north, the sign — if south. Add the latitudes, noticing the signs as in algebra, and the distance CG will be obtained. If its sign is — the point G is to be placed above C, but below C if the sign is +.

* See note with this mark in page 592.

† See note with this mark in page 592.

‡ See note with this mark in page 594.

*† The distance of the line WV from the line CR, the situation of the point P′ and the path of the spectator, may be found as in the note § page 594.

as before so as to make the transverse-distance of 60°, 60°, on the chords, equal to CB, and take the chord of the complement of the latitude of the place, which set from W on each side, to D and *d*. With the same opening of the sector measure the chord of the star's declination, which set on the circle ARB from the point D on each side, to E and F, and fr m *d* on each side to *e* and *f*. Draw the dotted lines F*f*, D*d*, E*e*, cutting CW in *l*, *q*, *n*. Bisect *l n* in *r*, and erect the line *t r u* perpendicular to CW and make *r t*, *r u* each equal to *q*D. Open the sector to make the transverse distance 90°, 90°, on the sines equal to *r t*, and on each side of *r* mark on the line *t r u* the sines of 15°, 30°, 45°, 60°, 75°, (equal to 1h. 2h. 3h. 4h. 5h. respectively) to that radius, and mark the points with those degrees as in the figure; through these points draw the dotted lines parallel to *ln* as in the figure. Open the sector so that the radius *r t* may correspond to the transverse distance 90°, 90°, on the sines, and measure the complements of the former degrees as transverse distances on the sines, viz. 75°, 60°, 45°, 30°, 15°, and set them on the above dotted lines, on each side of the points 15°, 30°, &c. respectively, above and below the line *t r u*. A regular curve *n t l u n* drawn through the extremities of these dotted lines, will represent the path of the spectator in the given latitude. Subtract the sun's right ascension from the star's (increasing the latter by 24 hours when necessary) the remainder will be the hour of the star's passing the meridian,* which is to be marked at the upper point *l* of the path if the star's declination is south, but at the lower point *n* if the declination is north. The other hours are to be marked from this point towards the left, by marking successively, at the points where the dotted lines meet the path, the hour of the star's passing the meridian, increased by 1h. 2h. 3h. &c. completely round the curve, observing to reject 24 hours when the sum exceeds 24h. In the present example the star's declination is south, consequently the upper point *l* of the path is taken for the hour of passing the meridian 19h. 54'. The extremities of the dotted lines to the left being marked successively 20h. 54', 21h. 54', 22h. 54', 23h. 54', 0h. 54', &c. The path touches the circle ARB in two points, representing the points of rising and setting of the star, which in the present figure are 14h. 9' and 1h. 39'. These points divide the path into two parts, of which one represents the path while the star is above the horizon, the other when below, as is evident from the hours marked on the curve. The half hours or any other intermediate time may be marked in a similar manner. Thus, for the time 4h. 24', which is 3h. 30' or 52° 30' from the time 7h. 54', marked at the point *n*; set the sine of 52°½ to the radius *r t* from *r* to *h* on the line *rt*, and erect the perpendicular *hi*, equal to the sine of 37°½ (which is the complement of 52°½) to the radius *rn*, and the point *i* will represent the place of the spectator at the proposed time. In this way the halves and quarters of hours may be marked on those parts of the path where necessary. The smaller subdivisions may generally be obtained to a sufficient degree of exactness by dividing the quarters of hours into equal parts.

Take from the scale of equal parts an extent equal to the semi-diameter of the moon, and beginning at the line NL towards N, find by trials the point *p'* of the moon's path and the point Z' of the path of the spectator, marked with the same time and at that distance apart. That time will be the beginning of the occultation or immersion at the proposed place. Proceed in the same way towards the point L, and find the points *p*, Z, at the same distance apart, the corresponding time will be the end of the occultation or emersion. About the points *p'*, *p*, as centres, with a radius equal to the moon's semi-diameter, describe the small circles meeting the paths of the spectator in the points Z', Z. These circles will represent the moon's disc; the points Z', Z, the places of the star, and the lines CZ', CZ, the vertical circles passing through the star at the times of immersion and emersion respectively. To render this part of the scheme more distinct to the eye, it is drawn separately in Fig. 9, Plate XII. in which the point C, *p'* Z', are similarly situated to the corresponding points of Fig. 8, marked with the same letters. Through *p'* draw the line *a' p c'* parallel to CZ', to meet the moon's disc in *a'*, *c'*. Then the circle *a' Z' c'* being held between the eye of the observer and the sun, the engraved or marked side of the figure towards the eye, and the line CZ' (or *a' p' c'*) in a vertical position with the point Z' above C, will represent the appearance of the moon and star as viewed by the naked eye, *c'* will represent the upper part of the moon, *a'* the lower part, and Z' the point of contact. The contrary will be observed if the object be viewed by an inverting telescope. It will generally be conducive to the accuracy of an observation to estimate in this manner the point of emersion, so as to keep that point of the moon's limb in the field of view of the telescope, and the eye directed towards that point of the limb, so as to perceive the star at the first instant of its appearance.—The situation of the point of emersion with respect to the horns ρ, θ, of the moon may also be made use of for this purpose. The line ρ p? connecting the moon's horns, is nearly parallel to the line CR, except very near the new or full moon, so that in general it will be sufficiently

* Or rather the horary distance of the ☉ and ✱ at the time of the ecliptic conjunction of the moon and star.

correct to draw through p the line $\rho\, p\, \theta$ parallel to CR. If greater accuracy is required, the following construction may be made use of. Subtract the sun's longitude from the moon's,* make the arch TYUλ equal to the remainder, and join Qλ. Set on the same circle the arch Tβ equal to the moon's latitude; *below* the point T if that latitude is *south*, *above* if *north*. Through β draw the line $\beta\, \epsilon\, \delta$ parallel to TQ to cut Qλ in ϵ and CR in δ. Take the extent QT and set it on the line δ Y above δ to μ. Join $\mu\, \epsilon$ and parallel thereto through p draw the line $\rho\, p\, \theta$ cutting the moon's disc in the points $\rho\, \theta$ representing the horns, the figure being viewed as above directed. The enlightened part of the moon is that nearest to the sun, the dark part is the most distant from it.

EXAMPLE.

Required the times of immersion and emersion of Spica, Dec. 12, 1808, at a place in the latitude of 20° N. and in the longitude of 1h. 9m. east from Greenwich?

By the first page of the Nautical Almanac for the month of December, 1808, the time of the ecliptic conjunction of the moon and Spica (marked ☽ α ♍) was, December 12, 17h. 33′ at Greenwich, corresponding to 18h. 42′ at the proposed place. At the time at Greenwich 17h. 33′ the elements of the occultation were as in the adjoined Table calculated by the above rule.

ELEMENT				
Conjunction at Greenwich	Dec. 12	17h.	33	
Longitude E. from do.		1	9	
Conjunction at place of observation		18	42	
✱'s R. ascen. Tab. VIII.		13	15	08
☉'s R. ascen by N. A.	Sub.	17	21	18
✱ passes the meridian		19	53	50
Latitude of the place		20°	0′	0″
☽'s horizontal parallax by N. A.	CB		59	55.2
☽'s semi-diameter by N. A.			16	19.8
☽'s horary mot. in long. Prob. II.	CO		35	55.2
☽'s horary mot. in lat. Prob. II.	CP	—	3	02.7
✱'s longitude, Tab. XXXVII.	TYV	201	10	31
☽'s latitude by N. A.		1	49	53 S.
✱'s latitude, Tab. XXXVII.		2	2	13 S.
Diff. of latitudes ☽ N. of ✱	CG		12	20 N.
✱'s declination		10	10	S.

Draw ACB, and perpendicular thereto the line CGY. Make CG equal to the difference between the latitudes of the moon and star 12′ 20″ taken from a scale of equal parts, the point G being above C, because the moon is northward of the star. Make CO equal to the moon's horary motion in longitude 35′ 55″.2 to the right of C; and CP equal to the horary motion in latitude 3′ 2″.7, the point P being above C because the sign is — (or the latitude is south decreasing.) Draw NGL parallel to OP. Make OP a transverse distance of 60, 60, on the line of lines of the sector, and measure from the same lines the transverse distance 42, 42 (corresponding to the minutes in the time of the conjunction) this distance set on the line GN, from G towards the right hand, reaches to the point x of the path where the hour preceding the conjunction is to be marked, viz. 18h. Take OP in the compasses, and mark it on the line LN, from x or 18h. to the right to 17h. and to the left to 19h. 20h. &c. These are subdivided into five minutes, the scale not admitting of smaller divisions. Take the moon's parallax 59′ 55″.2 from the scale of equal parts, and with that radius describe about the centre C the circle ARB. Set off (by means of the sector) the arches RT, RU, each equal to 23° 28′. Join TQU, and about that diameter describe the circle TYUVT. Make the arch TYV equal to the star's longitude 201° 10′ 31″, which is done by making the arch UV=21° 10′ 31″. Draw P′V parallel to CR, and with an extent equal to the complement of the star's declination 79° 50′, taken as a transverse distance from the sines, with the radius CB; and with one foot in C, sweep an arch cutting P′V in P′. Join CP′ and continue it to meet the circle ARB in W. Set on each side of W the arches WD, Wd equal to the complement of the latitude of the place 70°. Make the arches DF, DE, $d\, f$ de each equal to the star's declination 10° 10′, and draw the lines F l f, D q d, E n e, cutting CW in l, q, n, Bisect $l\, n$ in r, draw $t\, r\, u$ parallel to D q d, and make $r\, t$, $r\, u$ equal to q D. Through the points l, t, n, u, l, draw the path of the spectator as taught in the above rule, and mark the hour of the star's passing the meridian 19h. 53′ 50″ or 19h. 54′, at the upper point l, because the star's declination is south. Mark the following hours in succession 20h. 54′, 21h. 54′, &c. to the left, as in the figure. Take an extent in the compasses equal to the moon's semi-diameter 16′ 19″.8 and beginning towards N, find as above directed the points p', Z′, at that distance apart, and marked with the same time 16h. 57′, which is the time of the immersion. Proceed in the same way for the emersion corresponding to the points p, Z, at the same distance apart, and the time of the emersion 18h. 10′ will be obtained. With the same extent describe about p and p' the small circles representing the disc

* In strictness the longitude and latitude of the moon at the time of immersion or emersion ought to be made use of, but it will be sufficiently exact to use the star's longitude instead of the moon's (increasing it by 360° when less than the sun's longitude) and the moon's latitude at the conjunction. Quantities of the same order as the moon's parallax are neglected in the value of the arch TYUλ.

of the moon at these times, and cutting the path of the spectator in the point Z, Z′. Join CZ′, Cp', and parallel to CZ′, draw c', p' a' cutting the moon's disc in c', a' (as in Fig. 9, P. XII.) and the arch a Z will represent the distance of the point of immersion from the lower part a' of the moon. The line CZ runs nearly through the point p, so that the top part of the moon c and the point Z nearly coincide, consequently the emersion happened near the moon's zenith. By subtracting the sun's longitude 261° 7′ from the moon's or star's 201° 10′, (increased by 360°) the remainder is 300° 3′, which is to be marked on the circle TYUV to the point λ. Make the arch Tβ equal to the moon's latitude 1° 49′ 53″, taking the point β below T, because the latitude is south. Draw the lines λ Q β ϵ δ, μ ϵ, ρ p θ as in the rule, and the points ρ, θ, will represent the places of the moon's horns. The point of emersion Z will be to the westward of the upper horn ρ, about 60° measured on the moon's limb.

REMARKS.

1. When it is thought necessary to take notice of the spheroidal form of the earth, the corrections of latitude and parallax of Table XXXVIII. must be subtracted from the latitude of the place and the moon's horizontal parallax respectively, to obtain the latitude and parallax to be made use of in the above rule.

2. Subtract 2′ from the moon's semi-diameter given by the N. A. the remainder is to be made use of *without augmentation*, on account of the altitude of the moon.

3. The corrections for the change of the moon's semi-diameter, horizontal parallax, and horary motion during the occultation, are neglected in the above rule, as not materially affecting the result.

4. The line C Z′, measured on the sines as a transverse distance to the radius C B, will be the star's zenith distance at the immersion. In a similar manner it may be found at the emersion at Z, or at any other point.

5. The curve l t n u may be made to answer for any latitude, as in Problem XI. Remark 7.

Calculation of an Occultation of a Planet by the Moon.

By a similar process the times of immersion and emersion of a planet may be calculated by finding the planet's right ascension and declination, geocentric longitude and latitude from the Nautical Almanac, and using them instead of the star's. Also by Prob. II. the horary motion of the moon from the planet in longitude and latitude, which are to be used instead of the horary motion of the moon. In this projection it will not be necessary to take notice of the parallax of the planet, but it may be easily allowed for, by taking the radius C B equal to the difference of the horizontal parallaxes of the moon and planet. The apparent diameter of the planet may also be neglected, making the distances pZ, p'Z′ equal to the moon's semi-diameter. When great accuracy is required, the sum of the semi-diameters of the moon and planet must be made use of for finding the external contacts, and their difference for the internal contacts.

PROBLEM XIII.

To calculate the beginning or end of a solar Eclipse.

RULE.

This must be done by approximation, by assuming a time for the beginning or end of the eclipse, as for example the time obtained by projection by Problem XI. the time of new moon at the place of observation, or an hour before or after, according as it is the beginning or end of the eclipse that is sought. With this time calculate the elements of the eclipse and the parallaxes, as taught in the first part of Problem VIII. The parallaxes applied to the longitude and latitude of the moon by the N. A. will give the apparent longitude and latitude. Find the difference of the apparent longitudes of the moon and sun, and from its prop. log. increasing the index by 10, subtract the prop. log. of the moon's apparent latitude, the remainder will be the log. tangent of an angle, whose corresponding log. co-sine is to be added to the prop. log. of the diff. of longitudes, the sum, rejecting 10 in the index, will be the prop. log. of the apparent distance of the centres of the sun and moon, which ought to be equal to the sum of the corrected semi-diameters, if the assumed time was correct. If this is not the case, the operation must be repeated with an assumed time differing a few minutes from the former, and the apparent distance of the centres of the sun and moon must be calculated in this new supposition. Then add together the arith. comp. of the prop. log. of the difference of the apparent distances thus calculated, the prop. log. of the difference between the first calculated distance and the sum of the semi-diameters, and the prop. log. of the interval of time between the two suppositions, the sum, rejecting 10 in the index, will be the prop. log. of the correction to be applied to the first assumed time, which at the beginning of an eclipse is to be *added* to the first assumed time, if the distance be *greater* than the sum of the semi-diameters, but *subtracted* if *less*; and the contrary in calculating the end of an eclipse; the sum or difference will be the *approximate* time of the beginning or end

of the eclipse. If great accuracy is required, the operation may be repeated with this approximate time, combining this result with one of the former suppositions, and thus the operation may be repeated till the apparent distance of the centres at the assumed time is found to be exactly equal to the sum of the corrected semi-diameters.

Remark. This rule, with some modification, will answer for calculating the time of an occultation of a fixed star or planet by the moon. In this case the star's longitude is to be found in Table XXXVII. and corrected for the equation Tables XL. XLI. (or the planet's longitude is to be taken from the Nautical Almanac) the difference between this and the moon's apparent longitude corresponding to the assumed time being found, its prop. log. is to be added to the log. secant of the moon's apparent latitude, and the sum is to be used in finding the distance of the centres instead of the prop. log. of the diff. long. of the sun and moon, with the index increased by 10. The latitude of the star is to be found by Tables XXXVII. and XLI. or the planet's latitude by the Nautical Almanac, and added to the latitude of the moon, if of a different name, otherwise their difference is to be taken and made use of, instead of the moon's latitude in the above rule. Lastly, instead of the sum of the semi-diameters, the semi-diameter of the moon is to be made use of. When very great accuracy is required, in calculating an occultation of a planet by the moon, the difference of the parallaxes of the moon and planet decreased by the correction of Parallax Table XXVIII. is to be made use of as the reduced parallax, in finding the parallaxes in longitude and latitude. When the apparent distance of the centres of the moon and planet is equal to the sum of their semi-diameters, their limbs will just appear to touch each other, and when that distance is equal to the difference of the semi-diameters, the planet will be wholly covered by the moon.

EXAMPLE.

Required the time of the beginning of the solar eclipse of June, 1806, at Salem, supposing the errors of the moon's longitude and latitude in the Nautical Almanac to be unknown?

To abridge the present calculation, suppose the beginning of the eclipse to be June 15d. 22h. 6′ 18″.1 app. time. the elements corresponding to which have been calculated in Problem VI.; namely, ☽'s apparent longitude 84° 8′ 50″.3, ☽'s apparent latitude, 1′ 55″.8 N. these being corrected for the errors of the tables, 58″.5 and 11″.4, hence the uncorrected values are 84° 9′.48″.8, and 2′ 7″.2 N. The difference between this app. long. of the moon and the sun's longitude 84° 41′ 3″.4, is 31′ 14″.6.

Diff. long.	31′ 14′ .6	P. L.	10.7605		0.7605
☽ App. Lat.	2 7 .2	P. L.	1.9289		
		Tan.	8.3316	—Corresponding co-sine	9.9990
		App. Dis. ⊙ ☽		31′. 19″.0 P. L.	.7595

This apparent distance differs 1′ 4″.5 from the sum of the semi-diameters 32′ 23″.5. It is therefore necessary to make a second supposition, as for example ten minutes later, or at 22h. 16′ 18″.1, with this time the elements are to be again calculated as in Problem VI. namely, ☽'s app. long. uncorrected 84° 14′ 7″.1, ⊙'s long. 84° 41′ 27″.2, their difference 27′ 10″.1, ☽'s app. lat. uncorrected for error of tables 1′ 58″.8 N.

Diff. long.	27′.10″.1	P. L.	10.8212		0.8212
☽ App. Lat.	1 .58 .8	P. L.	1.9586		
Tang.			8.8626	Corresp. co-sine	9.9988
Second App. Dist. ⊙ ☽		27′. 14″.7		P. L.	.8200
First App. Dist. ⊙ ☽		31. 19 0			
Difference		4. 4. 3		P. L. Ar. co.	8.3545
Diff. 1st. dist. & Semi-diam.		1. 4. 5		P. L.	2.2283
Interval		10. 0.		P. L.	1.2553
Correction		2. 38.		P. L.	1.8386
First supposed time		15d. 22h. 6. 18.1			
Approximate time		15. 22. 8. 40.1			

If this approximate time had differed very much from the assumed times, it would be necessary to repeat the operation till the last assumed and calculated times agree.

PROBLEM XIV.

Given the moon's true longitude to find the apparent time at Greenwich.

RULE.

1. Take from the Nautical Almanac the two longitudes immediately preceding

the given longitude and the two following, and find the first and second differences as in Problem I. Call the middle term of the first differences the arch A, and the half sum of the second differences (noting the signs) the arch B.

2. To the constant logarithm 4.63548 add the arithmetical comp. log. of A in seconds, and the logarithm of the difference in seconds between the given longitude and the second longitude taken from the Nautical Almanac, the sum, rejecting 10 in [illegible]ex, will be the logarithm of the *approximate* time T in seconds.

3. Enter Table XLV. with the arch B at the top, and this time T at the side, and find the corresponding correction: to the logarithm of which add the two first logarithms above found, the sum, rejecting 10 in the index, will be the *correction* of the approximate time to be applied with the *same* sign as the arch B, and the correct apparent time, counted on from the second noon or midnight, will be obtained.

EXAMPLE.

Suppose the moon's longitude Dec. 12, 1808, was 6s. 19° 38′ 58″. Required the apparent time? As in Example I. Problem I. A=7° 11′ 18″.=25878″. B=+4′ 54″.5 and the difference between the given longitude and the second longitude, taken from the Nautical Almanac, 6s. 17° 51′ 36″ is 1° 47′ 22″.=6442″. Hence (as in the following calculation) the *approximate* time past midnight is 2h. 59′ 14″, this and the arch B gives, in Table XLV. the equation 27″.5 whence the *correction* is +46″, and the sought time 3h. past midnight or Dec. 12d. 15h.

	Constant log.	4.63548			4.63548
A	25878″ Ar. co. log.	5.58707			5.58707
Diff. long.	6442″ log.	3.80902	Eq. Table XLV. 27″.5	Log.	1.43933
Approx. time	2h. 59′ 14″=10754″ log.	4.03157	Correction+46″.	Log.	1.66188

PROBLEM XV.

Given the distance of the moon from a fixed star not marked in the Nautical Almanac, together with the altitudes of the objects, the apparent time of observation, and the estimated longitude, to find the longitude of the place of observation.

RULE.

To the apparent time of observation, by astronomical computation, add the estimated longitude in time, if west; subtract, if east, the sum or difference will be the supposed time at Greenwich, corresponding to which find the moon's latitude by Problem I, also the longitude and latitude of the Star by Table XXXVII. and correct them for aberration and nutation, by Tables XL. XLI.

With the apparent altitudes and distance of the objects, find the *correct* distance by the usual rules of working a lunar observation.

To the correct distance add the latitudes of the moon and star, and find the *difference* between the *half sum* and the distance. Then to the log. secants of the latitudes of the moon and star, rejecting 10 in each index, add the log. *co-sines* of the half sum and difference if the latitudes are of the *same* name; or the log. *sines* if of a *contrary* name; half the sum of these four logarithms will be the log. *co-sine* of half the difference of longitude if the latitudes are of the *same* name, or its log. sine if of a *different* name.

The difference of longitude is to be added to the apparent longitude of the star if the moon is east of the star, otherwise subtracted (borrowing or rejecting 360° when necessary;) the sum or difference will be the true longitude of the moon, whence the time at Greenwich may be found by Problem XIV. The difference between this and the apparent time at the ship will be the longitude, which will be *west* if the apparent time at Greenwich be greater than the time at the ship, otherwise *east*.

REMARK.

This method, with a slight modification, will answer for finding the longitude from the observed distance of the moon from a planet, as Jupiter, Venus, Mars, or Saturn. The only difference consists in finding from the Nautical Almanac by Problem I. the Geocentric long. and lat. of the planet, which are to be used instead of the longitude and latitude of the star in the above rule. For the daily variation of the longitude and latitude of a planet is so small, that no error of moment can arise from calculating those quantities for the *supposed* instead of the *true time*, at Greenwich, and the parallax and semidiameter of the planet are so small as not to affect the calculation materially.

The latitudes of the moon and the fixed star or planet made use of in these observations, ought not to differ very much, on account of the decrease of the relative motion arising from this source. If the latitudes are of a different name, their sum; otherwise their difference ought to be found, and if it does not exceed one third part of the difference of longitude of the two objects, they may in general be made use of.

EXAMPLE.

Suppose that on the 7th. January, 1808, sea account, at 6h. 57m. P. M. in the longitude of 120° W. by account, the observed distance of the farthest limb of the moon from the star Aldebaran was 39° 7′ 4″, the observed altitude of the star 43° 18′, and the observed altitude of the moon's lower limb 52° 52′. Required the true longitude, without using the distances marked in the Nautical Almanac, upon the supposition that they were not given in it ?

In this case the supposed time at Greenwich was Jan. 6d. 14h. 37m. ☽'s horiz. par. 54′ 35″, ☽'s S. D. 15′ 5″. Apparent distance of centres ☽ ✳ 38° 51′ 59″, whence (by the rule page 167) the correct distance is 38° 47′ 26″. The Moon's latitude deduced from the Nautical Almanac by Problem I. is 2° 37′ 36″ N. The Star's longitude and latitude is found by Tables XXXVII. XL. XLI. making use of the longitude of the Moon's node 7s. 28° 15′, and the Sun's longitude 9s. 15° 42′, as given in the Nautical Almanac.

Table XXXVII. ✳ Long. Jan. 6, 1808,	67°.6′.21″.5	✳ Latitude	5°.28′.49″.6 S.
Table XLI. ✳ Aberration	+ 15 .7	Aberration	+ 1 .2
Table XL. Equat. Equinox	+ 15 .2	✳ App. Lat.	5 28. 51 S.
✳ Apparent longitude	67. 6. 52		

Correct Distance	38.47. 26		
☽ Latitude	2.37. 36	N. Sec.	0.00016
✳ Latitude	5.28. 51	S. Sec.	0.00159
Sum	46.53. 53		
Half sum	23.26. 56	Sine*	9.53061
Diff. ½ sum and dist.	15 20. 30	Sine*	9.42255
			19.02481
½ Diff. of Long.	18.59. 21	Sine*	9.51240
Diff. of Long.	37.58. 42	☽ West of ✳	
✳'s Longitude	67. 6. 52		
☽ Longitude	29. 8. 10		
☽ Long. Jan. 6d. 12h.	27.49. 6		
Difference	1.19. 4=4744″		

☽ Longitude, Jan.		° ′ ″	Diff.	2 Diff.
	6d. 0h.	21. 53. 10		
	6. 12	27. 49. 6	5.55.56	+1°.30″
	7. 0	33. 46. 32	A 5.57.26	+2. 8
	7. 12	39. 46. 6	5.59.34	Mean B. +1. 49

Constant log.	4.63548		4.63548
A=5°.57′.26″=21446″ log. co.	5.66865		5.66865
1. 19. 4 = 4744″ log.	3.67614	Eq. Tab. XLV.+9″.4 Log.	0.97313
Approx. time 2h. 39′ 16″=9556″ Log.	3.98027	Correction + 19″ Log.	1.27726
Correction	+ 19		
Time T	2. 39. 35		

Hence time at Greenwich	14h. 39′ 35″
App. time at ship	6. 37. 0
Longitude	8. 2. 35=120°.38′¾ W.

PROBLEM XVI.

Given the intervals of time between the passages of the moon's limb and a fixed star over two different meridians, to find the difference of longitude of the two meridians.

In making these observations it is usual to note the times of transit by a clock regulated to siderial time, being the most convenient for calculation. If the intervals are given in *mean* solar time, they may be reduced to siderial, by adding a proportional part of the daily difference 3′ 56″.6. Thus if the interval was 6 hours mean time, the correction would be found by saying as 24h. : 6h. : : 3′ 56″.6 : 59″.1, which added to 6h. gives the interval in siderial time 6h. 0′ 59″.1. In the following rule it is supposed that the intervals are given in siderial time. The constant logarithm 4.63667 made use of in the rule, is the logarithm of 43318 seconds, the number of seconds siderial time in half a *mean* solar day. In strictness this quantity ought to be equal to the logarithm of the number of seconds siderial time in 12 hours *apparent* time, which may differ 15 seconds from 43318″ on account of the daily variation of the equation of time. The correction arising from this source is very small, and may in general be neglected, though it can be allowed for in a very simple manner, since the logarithm varies an unit in the fifth decimal place for 1″ of time. Hence the correction of the logarithm is equal to half the daily variation of the equation of time in

* Use cosine if the latitudes are of the same name.

seconds, given in the Nautical Almanac, to be *added* to 4.63667 when the equation of time is marked *add* and is increasing, or *sub.* and decreasing; otherwise *subtracted.* Thus if the observation was made July 4, 1808, the equation of time is marked add, and is increasing daily 10″.5. half of which or 5 is the correction to be added to 4.63667 to obtain the logarithm 4.63672, to be made use of July 4, 1808.

RULE.

If the moon be observed at both places on the same side of the star, take the difference of the observed intervals, otherwise the sum, which reduce to seconds of siderial time, and find the corresponding logarithm, to which add the arith. comp. log. of the variation of the moon's right ascension* in 12 hours in seconds, and the log. 4.63667 (corrected for the variation of the equation of time, as directed above, when very reat accuracy is necessary.) The sum, rejecting 10 in the index, will be the log. of a number of seconds, from which subtract the above difference of intervals, the remainder will be the longitude in time.

The *western* place of observation corresponds to the *greater* interval if the star is *west* of the moon, the *less* if *east.* If the moon be observed on opposite sides of the star, the western place will be where the star is to the westward of the moon.

EXAMPLE.

Suppose that on the 4th. of July, 1808, the interval in siderial time between the transit of the moon's western limb and Antares, observed at Greenwich, was 22′ 6″; and the interval at a second place was 20′ 3″; the increase of the moon's right ascension in 12 hours (corresponding to the middle time of the moon's transit by the meridians of the two places reduced to Greenwich time, 9h. 26′) being by Prob. II. Ex. III. 30′ 22″.1 the star being to the eastward of the moon. Required the longitude of the second place of observation?

Interval at Greenwich	22′. 6″	Sid. time		
.... at second place	20. 3			
Diff. of intervals	2. 3 = 123″		log.	2.08991
Var. ☽ R. A. in 12h. 30′ 22″.1. in time = 1822″.1			log. co.	6.73943
Constant log. Corrected as above.				4.63672
	2925″		log.	3.46606
Subtract diff. intervals	123			
Remains long. in time	2802 = 46′ 42″ W. from Greenwich.			

This method of determining the longitude admits of a very great degree of accuracy on account of the frequent opportunities of observation. Other methods of finding the longitude depending on the same principles have been proposed. One consists in observing the apparent time of the moon's passing the meridian, and comparing it with the time of passing observed at Greenwich, or deduced from the Nautical Almanac, and taking the difference of these times, and saying, as the daily difference of the moon's passing the meridian (deduced from the Nautical Almanac for the time of observation) is to 360°, so is the above difference to the longitude of the place. Another method consists in deducing the longitude from the change of declination of the moon, obtained from her observed altitude when on the meridian, and the known latitude of the place of observation, by a method somewhat similar to the preceding; but neither of these methods is susceptible of the same degree of accuracy as that in the above Problem.

It is not absolutely necessary that the same star should be made use of at both places; for if two stars be observed, whose difference of right ascension is accurately known, that difference will be equal to the interval of passing of the two stars to the meridian in the siderial time, and by applying this to one of the intervals, the observations may be reduced to be the same as if one star only had been used.

PROBLEM XVII.

Given the longitudes of the sun and moon, and the moon's latitude, to find their distance.

RULE.—Find the difference of the two longitudes, and to its log. co-sine add the log. co-sine of the moon's latitude, the sum, rejecting 10 in the index, will be the log. co-sine of the sought distance, of the *same affection*† as the difference of longitude.

EXAMPLE.

July 16, 1808, at noon at Greenwich, by the Nautical Almanac, the sun's longitude was 3s. 23° 40′ 24″, the moon's longitude 1s. 3° 14′ 1″, and her latitude 1° 24′ 28″ N. Required their distance?

* In general it will be exact enough to take the difference between the moon's R. A. marked in the Nautical Almanac for the nearest noon and midnight, but when very great accuracy is required, it may be found as in Prob. II. Ex. III. for the middle time between the two transits of the moon by the meridians of the two places, reduced to Greenwith time by adding the longitude if west, subtracting if east. If absolute accuracy is required, it would be proper to notice the variation of the moon's semidiameter and declination between the observations, also to compute the effect of the variations of the horary motion, noticing the higher order of differences, but these circumstances would affect the result but very little.

† Two arches or angles are said to be of the *same affection* when they are *both greater or both less than* 90°, but of *different affection* when the *one is greater and the other less than* 90°.

☉ Longitude	113° 40′ 21″		
☽ Longitude	33 14 1		
Diff. long.	80 26 23	co-sine	9.22033
☽ Latitude	1 24 28	co-sine	9.99987
Distance	80 26 33	co-sine	9.22020

The same as in the Nautical Almanac. The distances being calculated from noon and midnight by this (or the following) Problem, they may be interpolated for every 3 hours by Problem I. An example will sufficiently illustrate this.

EXAMPLE.

Given the distances of the sun and moon in July, 1808, at 15d. 12h. 16d. 0h. 16d. 12h. and 17d. 0h.; respectively 85° 52′ 13″ | 80° 26′ 33″ | 75° 0′ 44″ | and 69° 34′ 9″. Required the distances July 16d. at 3h. 6h. and 9h.?

1808, July	Dist. ☉ ☽	1st diff. ° ′ ″	2d. diff. ″
15d. midnight	85°. 52′. 13		
16 noon	80. 26. 33	—5. 25. 40	— 9
16 midnight	75. 0. 44	A.=—5. 25. 49	—46
17 noon	69. 34. 09	—5. 26. 35	B=—27½

At 3h.			At 6h.			At 9h.		
Second longitude	+	80. 26. 33		+	80. 26. 33		+	80. 26. 33
Prop. part ¼ A	—	1. 21. 27.2	½ A	—	2. 42. 54.5	¾ A	—	4. 4. 21.7
Table XLV. T 3h.	+	2.6	T=6h.	+	3.4	T=9h.	+	2.8
Distance at 3h.		79. 5. 8	Dist. at 6h.		77. 43. 42	Dist. at 9h.		76. 22. 14

These distances agree with the Nautical Almanac.

PROBLEM XVIII.

Given the longitudes and latitudes of the moon and a star, to find their distance.

RULE.

To the log. secant of the difference of longitude of the moon and star, rejecting 10 in the index, add the log. tangent of the greater latitude, the sum will be the log. tangent of the arch A, of the same affection as the difference of longitude. Take the *sum* of the arch A, and the less latitude, if the latitudes are of a *different* name, but their *difference* if of the *same* name, and call it the arch B. Then add together the log. secant of the difference of longitude, the log. secant of the greater latitude, the log. co-sine of the arch A, and the log. secant of the arch B, the sum, rejecting 30 in the index, will be the log. secant of the distance of the moon and star of the same affection as B.

EXAMPLE.

Required the distance of the moon and the star α Pegasi at noon at Greenwich, July 16, 1808, when by the Nautical Almanac the moon's longitude was 33° 14′ 1″, latitude 1° 24′ 28″ N. and by the explanation of Tables XL. XLI. the longitude of the star corrected for aberration and equation of equinoxes was 350° 49′ 36″, and its latitude corrected for aberration 19° 24′ 41″ N.?

☽'s long.	33° 14′ 1″					
✳ long.	350 49 36					
Diff. long.	42 24 25		secant	0.13173		10.13173
Greater lat.	19 24 41	N.	tang.	9.54701	secant	10.02542
Arch A	25 30 45		tang.	9.67874	co-sine	9.95541
Lesser lat.	1 24 28	N.				
Arch B	24 6 17				secant	10.03962
Distance ☽ ✳ 45° 15′ 23″					secant	10.15221

It may be observed that the log. secant of the distance is also equal to the sum of the log. co-secant of the greater latitude, the log. sine of arch A, and the log. secant of the arch B, rejecting 20 in the sum of the indices; but the above rule is in general the most convenient on account of the smallness of the greater latitude, except when the difference of longitude is nearly equal to 90°.

PROBLEM XIX.

Given the right ascension and declination of a celestial object, with the mean obliquity of the ecliptic E, to find its longitude and latitude.

RULE.

To the log. tangent of the declination add the log. co-secant of the right ascension of the object, the sum, rejecting 10 in the index, will be the log. tangent of the arch A, to be taken out less than 90°, and called *north* or *south* as the declination is. If the right ascension is *less* than 180°, call the obliquity of the ecilptic *south*, if above 180°, *north*. If A and E are of the same name, take their sum, otherwise their difference, which call B, and mark it with the same name as the greater number, whether N. or S. Then add together the log. secant of A, the log. co-sine of B, and the log. tangent of the right ascension, the sum, rejecting 20 in the index, will be the log. tangent of the longitude in the same quadrant as the right ascension, unless B be greater than 90°, in which case the quantity found in the same quadrant as the right ascension, subtracted from 360°, will be the longitude.

To the log. sine of the longitude add the log. tangent of B, the sum, rejecting 10 in the index, will be the log. tangent of the latitude of the same name as B.

Remark. As the Tables of this collection are not marked above 180°, you must subtract 180° from the right ascension when it exceeds that quantity, and find the log. tangent and log. co-secant of the *remainder;* and then the arch, corresponding to the log. tangent of the longitude, is to be taken of the same affection as this remainder, and 180°, added thereto, the sum will be the longitude, unless B is greater than 90°, in which case the supplement of that sum to 360° is to be taken as observed above.

EXAMPLE.

By Table VIII. the right ascension of *a* Pegasi, July 16, 1808, was 22h. 55′ 14″= 343° 48′ 30″, and its declination 14° 11′ N. the mean obliquity of the ecliptic 23° 27′ 47″. Required its longitude and latitude ?

Declin.	14° 11′ 0″ N.	tang.	9.40266				
R. A.	343 48 30	co-sec.	10.55462	tang.	9.46295		
A	42 11 12 N.	tang.	9.95728	sec.	10.13020		
E	23 27 47 N.						
B	65 38 59 N.			co-sine	9.61522	tang.	10.34431
		Longitude 350° 49′ 19″		tang.	9.20837	sine	9.20277
				Lat. 19° 24′ 51″ N.		tang.	9.54708

PROBLEM XX.

The longitude and latitude of a celestial object being given, with the mean obliquity of the ecliptic E, to find the right ascension and declination.

RULE.

To the log. tangent of the latitude add the log. co-secant of the longitude, the sum, rejecting 10 in the index, will be the log. tangent of the arch A, which is to be called *north* or *south* as the latitude is. If the longitude is less than 180°, call the obliquity E *north;* if above 180°, *south.* If A and E are of the same name, take their *sum,* otherwise their *difference,* which call B, marking it with the same name as the greater number. Then add together the log. secant of A, the log. co-sine of B, and the log. tangent of the longitude, the sum, rejecting 20 in the index, will be the log. tangent of the right ascension in the same quadrant as the longitude, unless B be greater than 90°, in which case the quantity found in the same quadrant as the longitude, subtracted from 360°, will be the right ascension.

To the log. sine of the right ascension add the log. tangent of B, the sum, rejecting 10 in the index, will be the log. tangent of the declination of the same name as B.

Remark. If the longitude exceeds 180° you must subtract 180° from it, and find the log. tangent and log. co-secant of the *remainder.* The arch corresponding to the log. tangent of the right ascension is to be taken of the same affection as this remainder, and 180° added thereto will be the right ascension, unless B is greater than 90°, in which case the supplement of that sum to 360° is to be taken as was observed above.

EXAMPLE.

By Table XXXVII. the mean longitude of *a* Pegasi, July 16, 1808, was 350° 49′ 11″, its latitude 19° 24′ 47″ N. and the mean obliquity of the ecliptic 23° 27′ 47″. Required its right ascension and declination ?

Lat.	19° 24′ 47″ N	tang.	9.54705				
Long.	350 49 11	co-sec.	10.79712	tang.	9.20847		
A	65 38 34 N.	tang.	10.34417	sec.	10.38466		
E	23 27 47 S.						
B	42 10 47 N.			co-sine	9.86984	tang.	9.95713
Right ascension	343° 48′ 28″			tang.	9.46297	sine	9.44539
			Declination	14° 10′ 50″ N.		tang.	9.40257

If the given longitude, latitude, and obliquity are the *mean* values, the resulting right ascension and declination will be the *mean* values, but if the proposed quantities are corrected for aberration and nutation, the resulting quantities will also be corrected. This remark is equally applicable to the preceding Problem.

SPHERIC TRIGONOMETRY.

Most of the rules given in the preceding Problems may be easily demonstrated by Spheric Trigonometry. As for example that of Problem XVII. may be investigated as follows. In Plate XII. Fig. 1, let A be the place of the moon, C that of the sun, CP an arch of the ecliptic, and AP a circle of latitude passing through the moon and cutting the ecliptic at right angles at P. Then the difference of longitude of the sun and moon is equal to the arch CP, and the moon's latitude is AP, whence the distance AC may be found by the rule of Napier, radius × co-s. AC = co-s. AP × co-s. CP. This in logarithms gives log. co-s. AC=log. co-s. AP+log. co-s. CP—log. radius, which is the formula made use of. Want of room prevents the insertion of the demonstrations of the methods of calculating the other Problems.

The celebrated rules given by Lord Napier for solving the problems of Right-Angled Spheric Trigonometry being very easily remembered, are much made use of by mathematicians. In a paper communicated by the author of this work to the American Academy of Arts and Sciences, and published in the third volume of the memoirs of that society, a method was given for the more easy application of those rules to oblique Spheric Trigonometry, and as the tables of this collection may sometimes be made use of in solving various problems of Spherics besides those given in the former part of this work, it was thought proper to insert this improved method, with the formulas most frequently made use of, to enable any person acquainted with Spheric Trigonometry to make use of the tables, without the trouble of referring to another work, for the rules.

In every Right-angled Spheric triangle there are *five circular parts;* namely, the two legs, the complement of the hypotenuse, and the complements of the two oblique angles, which are named *adjacent* or *opposite*, according to their positions, with respect to each other. The right-angle is not included as one of the circular parts, neither is it supposed to separate the legs. In all cases of right-angled Spheric Trigonometry, two of these parts are given to find the third. If the three parts join, that which is in the middle is called the middle part; if they do not join, two of them must, and the other part which is separate, is called the middle part, and the other two opposite parts, as in Plate XII. fig. 1, 2. Then putting the radius equal to unity, the equations given by Napier will become

Sine of middle part = Rectangle of the tangents of the adjacent parts.
= Rectangle of the co-sines of the opposite parts.

The method of applying these solutions to the various cases of Right-angled Spheric Trigonometry is very simple, and is explained in several treatises. To apply the method to Oblique-angled Spheric Trigonometry, it is necessary to divide the triangle into two right-angled spheric triangles by means of a perpendicular AP (Plate XII. fig. 3, 4, 5, 14.) let fall from the point A upon the opposite side BC: the perpendicular being so chosen *as to make two of the given things fall in one of the right-angled triangles,* or in other words *the perpendicular ought to be let fall from the end of a given side and opposite to a given angle.** Each triangle thus found, contains, as above, five circular parts, the perpendicular being counted and bearing the same name in each of them: consequently the parts of each triangle similarly situated with respect to the perpendicular, must have the same name. In every case of Oblique-angled Spheric Trigonometry, there are three parts given to find a fourth, and in making use of the method of a solution by means of the perpendicular, there will in general be two of these parts in each of the triangles ACP, ABP, similarly situated with respect to each other. To each of these must be joined the perpendicular AP, and there will be three parts in each triangle, which are to be named *middle, adjacent* or *opposite*, according to the above directions. Then the equations for solving all the cases of Right-angled, and all except two cases of Oblique-angled Spheric Trigonometry are,

1. *Sine middle part* $\left\{ \begin{matrix} = \\ \propto \end{matrix} \right\}$ *Tangents of the adjacent parts.*† / *Co-sines of the opposite parts.*

These equations, when applied to right-angled spheric triangles, signify as before, that the sine of the middle part is equal to the rectangle of the tangents of the adjacent parts, or to the rectangle of the co-sines of the opposite parts but when applied to an oblique-angled triangle, they signify, that the sines of the middle parts are proportional to the tangents of the adjacent parts; or that the sines of the middle parts are proportional to the co-sines of the opposite parts of the same triangle; observing that the perpendicular being common to both triangles APB, APC, and bearing the same name in each of them, must not be made use of in the analogies, nor counted as a middle part. This can produce no embarrassment, because the cases of Oblique Spheric Trigonometry may in general be solved in the shortest manner without calculating the perpendicular.

The first case not included in the above rules, is where the question is between two sides and the opposite angles, which may be solved by the noted theorem, that the sines of the sides are proportional to the sines of the opposite angles, or as it may be expressed in an abridged form or more easy reference.

2. *Sine side* $\propto$ *sine opp. angle.*

This, combined with the above improved formula, furnish a complete solution of the various cases of Spheric Trigonometry, except where three sides are given to find an angle, or (which is nearly the same thing, by taking the supplementary triangle) three angles to find a side. The above rules marked (1,) (2,) are simple in their

* When this can be done in two different ways (as in Cases II. IV.) it will generally produce the shortest solution, to make use of that perpendicular which does not divide the *required* angle or side into segments.

† It will be of considerable assistance in remembering these rules to note that the second letters of the words *tangent* and *co-sine* are the same as the first letters of *adjacent* and *opposite*.

form, and the first varies but little from that made use of by Napier, so that it is extremely easy to remember them. The case not included in these rules may be solved by one of the formulas of case V. or VI. which may be committed to memory with little trouble. To illustrate these rules, the following examples are given, which include all the cases of Oblique Spheric Trigonometry.

CASE I. PLATE XII. Fig. 3, 4, 5, 14.

Given AB, AC, and the opposite angle C, to find BC and the angles A, B.

In the right-angled spheric triangle APC are given AC and C, and by marking it as in fig. 2, CP may be found by the rules *sine mid.=tang. adj.* which gives sine (co. C)= tang. CP×tang. (co. AC,) or tang. CP=co-s. C×tang. AC.* Then in the triangles ABP, ACP are given AB, AC and CP to find BP. If to these is joined the perpendicular AP it will be found that in the triangle ACP the complement of AC is the middle part (as in Fig. 3), and CP an opposite part. The triangle ABP is to be marked in a similar manner. Then the rule *sine mid.* $\propto$ *co-s. opp.* gives sine (co. AC) : co-s. CP : : sine (co. AB) : co-s. BP, and $BC=BP\underset{\backsim}{+}CP$. By marking the segments as in Fig. 4, the rule *sine mid.* $\propto$ *tang. adj.* gives sine CP : tang. (co. C.) : : sine BP : tang. (co. B.) Having found BC, the angle A may be found by the rule *sine side.* $\propto$ *sine opp. angle* which gives sine AB : sine C : : sine BC : sine A.

Otherwise—If the side BC is not required, the angles A, B, may be found in the following manner. The rule *sine mid.=tang. adj.* gives by marking as in Fig. 1. sine (co. AC)=tang. (co. C)×tang. (co. CAP) or cot. CAP.=co-s. AC×tang. C, and by marking as in Fig. 5, the rule (sine mid. $\propto$ tang. adj. or) *tang. adj.* $\propto$ *sine mid.* gives tang. (co. AC) : sine (co. CAP) : : tang. (co. AB) : sine (co. BAP,) then $A=BAP\underset{\backsim}{+}CAP$. By marking the segments as in Fig. 14, the rule (sine mid. $\propto$ co-s. opp. or) *co-s. opp.* $\propto$ *sin. mid.* gives co-s. (co. CAP) : sine (co. C) : : co-s. (co. BAP) : sine (co. B) or sine CAP : co-s. C : : sine BAP : co-s. B. Having A, C, and AB, BC may be found by the rule *sine side* $\propto$ *sine opp. angle*, which gives sine C : sine AB : : sine A : sine BC.

CASE II. Fig. 3, 4. Plate XII.

Given AC, BC and the included angle C, to find AB, and the angles A, B.

The rule *sine mid.=tang. adj.* gives as in Case I. tang. CP=co-s. C×tang. AC, then $BP=BC\underset{\backsim}{+}CP$ and the rule *co-s. opp.* $\propto$ *sine mid.* gives by marking, as in Fig. 3. co-s. CP : sine (co. AC) : : co-s. BP : sine (co. AB,) and by marking as in Fig. 4, the rule *sine mid.* $\propto$ *tang. adj.* gives sine CP : tang. (co. C) : : sine BP : tang. (co. B.) Having found AB we may find A, by the rule *sine side* $\propto$ *sine opp. angle*, which gives sine AB : sine C : : sine BC : sine A.

If the angle A had been required and not B, it would have been shorter to let the perpendicular fall upon the point B, by which means the required angle A would not be divided into segments. In this case the side AB and the angle A might be found in a similar manner to that by which AB and B are found above.

CASE III. Fig. 3, 4, 5, 14. Plate XII.

Given the angles B, C, and the opposite side AC to find BC, AB, and the angle A.

The rule *sine mid.* $\propto$ *tang. adj.* gives as in Case I. tang. CP=co-s. C × tang. AC. Then the rule *tang. adj.* $\propto$ *sine mid.* gives, by marking as in Fig. 4, tang. (co. C.) : sine CP : : tang. (co. B) : sine B P, then $BC=CP\underset{\backsim}{+}BP$. Again, the rule *co-s. opp.* $\propto$ *sine mid.* gives by marking as in Fig. 3, co-s. C P : sine (co. AC) : : co-s. B P : sine (co. AB.) Having found BC, the rule *sine side* $\propto$ *sine opp. angle*, gives sine AC : sine B : : sine BC : sine A.

Otherwise—The rule *sine mid.=tang. adj.* gives as in Case I. cot. CAP=co-s. AC× tang. C, and the rule *sine mid.* $\propto$ *co-s. opp.* gives by marking as in Fig. 14, sine (co. C.) : co-s. (co. CAP) : : sine (co. B) : co-s. (co. BAP) or co-s. C. : sine CAP. : : co-s. B : sine BAP, and $A=CAP\underset{\backsim}{+}BAP$. Then the rule *sine mid.* $\propto$ *tang. adj.* gives by marking as in Fig. 5, sine (co. CAP) : tang. (co. AC) : : sine (co. BAP) : tang. (co. AB.) Having found A the rule, *sine side* $\propto$ *sine opp. angle* gives sine B : sine AC : : sine A : sine BC.

* In putting this or any similar expression in logarithms, the radius must be neglected in the sum of the two logarithms of the second number.

CASE IV. Fig. 5, 14. Plate XII.

Given the angles A, C and the included side AC, to find AB, BC and the angle B.

The rule *sine mid.*=*tang. adj.* gives as in Case I. cot. CAP=co-s. AC×tang. C, and BAP=A+CAP. The rule *sine mid.* ∝ *tang. adj.* gives by marking as in
∽

Fig. 5, sine (co. CAP) : tang. (co. AC) : : sine (co. BAP) : tang. co. (AB.) The rule *cos. opp.* ∝ *sine mid.* gives by marking as in Fig. 14, co-s. (co. CAP) . sine (co. C.) : : co-s. (co. BAP) : sine (co. B) or sine CAP : co-s. C : : sine BAP : co-s. B. Having found B, the rule *sine side* ∝ *sine opp. angle* gives sine B : sine AC : : sine A : sine BC.

If the side BC had been required and not AB, it would be shorter to let the perpendicular fall from the point C, by which means the required side BC would not be divided into segments. In this case the side BC and the angle B might be found in a similar manner to that by which AB and B are found above.

CASE V. Fig. 3.

Given AB, AC, and BC, to find either of the angles as A.

Put $S=\frac{1}{2}$ (AB+AC+BC,) then the angle A may be found by either of the following theorems, in which for brevity the words sine, co-sine, &c. are used for log. sine, log. co-sine, &c.

(3) $\text{Sine } \frac{1}{2} A = \dfrac{\text{Sine } (S-AB) + \text{sine } (S-AC) + \text{co-sec. } AB + \text{co-sec. } AC - 20.}{2}$

(4) $\text{Co-s. } \frac{1}{2} A = \dfrac{\text{Sine } S + \text{sine } (S-BC) + \text{co-sec. } AB + \text{co-sec. } AC - 20.}{2}$

CASE VI. Fig. 3.

Given the angles A, B, C, to find either of the sides as BC.

Put $S=\frac{1}{2}$ (A+B+C.) Then the side BC may be found by either of the following theorems, adapted to logarithms as in the last example.

(5) $\text{Sine } \frac{1}{2} BC = \dfrac{\text{Co-sine } S + \text{co-sine } (S-A) + \text{co-sec. } B + \text{co-sec. } C - 20.}{2}$

(6) $\text{Co-sine } \frac{1}{2} BC = \dfrac{\text{Co-sine } (S-B) + \text{co-sine } (S-C) + \text{co-sec. } B + \text{co-sec. } C - 20.}{2}$

The above includes all the cases of Oblique Trigonometry. The 2d. and 4th. cases may be solved in a different manner by the following theorems, which on some occasions may be found very useful. Thus both the angles in Case II. may be found by the following theorems.

(7) Sine $\frac{1}{2}$ (AC+BC) : sine $\frac{1}{2}$ (BC ∽ AC) : : cot. $\frac{1}{2}$ C : tang. $\frac{1}{2}$ (A—B).

(8) Co-sine $\frac{1}{2}$ (AC+BC) : co-sine $\frac{1}{2}$ (BC ∽ AC) : : cot. $\frac{1}{2}$ C : tang. $\frac{1}{2}$ (A+B).

$\frac{1}{2}$ (A—B) is less than 90° and $\frac{1}{2}$ (A+B) is of the same affection as $\frac{1}{2}$ (AC+BC). The sum and difference of the terms $\frac{1}{2}$ (A—B) and $\frac{1}{2}$ (A+B) will give A and B.

Both the sides in Case IV. may be found thus:

(9) Sine $\frac{1}{2}$ (A+C) : sine $\frac{1}{2}$ (A ∽ C : : tang. $\frac{1}{2}$ AC : tang. $\frac{1}{2}$ (BC ∽ AB).

(10) Co-sine $\frac{1}{2}$ (A+C) : co-sin. $\frac{1}{2}$ (A ∽ C) : : tang. $\frac{1}{2}$ AC : tang. $\frac{1}{2}$ (BC+AB.) $\frac{1}{2}$ (BC ∽ AB) is less than 90°, and $\frac{1}{2}$ (BC+AB) is of the same affection as $\frac{1}{2}$ (A+C.) Then the sum and difference of $\frac{1}{2}$ (BC ∽ AB) and $\frac{1}{2}$ (BC+AB) give AB and BC.

The improved rule for solving the cases of Oblique Spheric Trigonometry by the circular parts, may be easily deduced from those given by Lord Napier. For if we put M for the middle part, A for the adjacent part, and B for the opposite part of the triangle APC (Fig. 3, 4, 5, 14, Plate XII.) *m*, *a*, *b*, for the corresponding parts of the triangle APB; and P for the perpendicular AP. Then if P is an adjacent part, the rules of Napier will give tang. $P=\dfrac{\text{sine M}}{\text{tang. A}},$ and tang. $P=\dfrac{\text{sine } m}{\text{tan. } a},$ hence $\dfrac{\text{sine M}}{\text{tang. } a,}=\dfrac{\text{sine } m}{\text{tang. } a}$ consequently sine M : tang. A : : sine *m* . tang. *a*. If P is an opposite part, the same rule will give co-s. $P=\dfrac{\text{sine M}}{\text{co-s. B}}$ and co-s. $P=\dfrac{\text{sine } m,}{\text{co-s. } b,}$ hence $\dfrac{\text{sine M}}{\text{co-s. B}}=\dfrac{\text{sine } m}{\text{co-s. } b,}$ consequently sine M : co-s. B : : sine *m* : co-s. *b*, which are the two rules to be demonstrated.

APPENDIX TO THE SIXTH EDITION.

ON FINDING THE LATITUDE BY TWO ALTITUDES.

SINCE the part of this work for the finding the Latitude by two altitudes was in the press, the following Table XLVIII. has been computed, by means of which the correction of either one of the observed altitudes can be computed for the change of declination of the observed object during the elaped time between the observations, and thus the Problems of double altitudes of the sun, moon, planet, or fixed star, can be reduced to the case of the declination, being invariably the same as at the time of the observation of the altitudes which is not corrected, and then the Problem comes under the *first* (or second) method of solution, which is much more simple and free from cases than the general solution by the *third* method. This process of correcting the altitude is somewhat similar to that before taught, for making allowance for the run of a ship during the time elapsed between the observations; and the same altitude, which is corrected for the run of the ship, can also be corrected for the change of declination. This method of correcting one of the altitudes is particularly applicable to the case where *both* observations are made on the *same* heavenly body, and the declination does not vary but few minutes, or in extreme cases more than one or two degrees; but the same process may be used when two *different* objects are observed, provided their declinations are nearly equal, or do not differ more than one or two degrees.

As either one of the altitudes may be corrected, the Problem admits of two different ways of solution. For the sake of precision, the altitude which is selected to be corrected, will be called the *first altitude*; and the corresponding declination, the *first declination*; the other altitude, which is not corrected, will be called the *second altitude*, and the corresponding declination, the *second declination*. These terms, *first* and *second*, having no reference to the order in which these observations are taken, since the altitude here defined as the *first altitude*, may be actually observed either *before* or *after* the other observation

The proposed table gives for various declinations, altitudes, and latitudes, the change of the *first altitude*, corresponding to a variation of 100″ in the *first declination*. Thus, with the latitude 50° N. the sun's altitude 30°, and the declination 14° N. the Table gives 77″ for the variation of that altitude arising from a change of 100″ in the declination. If the actual change of declination is greater, or less than 100″ the tabular number 77″ must be increased or decreased in the same proportion. Thus, if the change of declination be 200″, the change of altitude will be $200'' \times \frac{77}{100} = 154''$. If the change of declination be 60′, the change of altitude will be $60' \times \frac{77}{100} = 46'$. The correction of this *first altitude* having been found, it is to be applied to the first altitude, corrected as usual, for dip, refraction, semi-diameter and parallax, and the *corrected* first altitude will be obtained, such as it would have been, if the declination at the time of observing that altitude had been equal to the *second declination*. With this corrected first altitude, the second altitude and second declination without correction, and the observed elapsed time, or hour angle, the computation of the latitude may be made by the *First Method*, explained in page 133.

This Table is calculated for every 2° of declination, from 0° to 26°. If the change of declination is not very great during the elapsed time, it will in general be sufficiently exact to enter the table with the nearest declination, and take proportional parts for the degrees of altitude and latitude. The latitude by account is to be used in finding the numbers from this table, it being sufficiently accurate, since an error of 1° of latitude rarely produces more than 2″ change in the numbers of the Table. Suppose now, that the tabular number was required, when the latitude was 37° N. the *first* altitude 28°, the first declination 6° 25′ S. In this case, using the declination 6°, and the altitude 20°, he tabular numbers corresponding to the latitudes 30° S. and 40° S. are, respectively, 57″ and 73″, whose difference 16″ corresponds to a change of 10° of latitude, and by

proportion, the change corresponding to 7° of latitude is $16'' \times \frac{7}{10} = 11''.2$, this added to 57″, gives the correction corresponding to the altitude 20° and the latitude 37° S. equal to 68″.2. Repeating now the same operation with the altitude 30°, the two tabular numbers are 64″ and 81″, whose difference 17″ multiplied by $\frac{7}{10}$ gives 11″.9 to be added to 64″ to get 75″.9, the correction corresponding to the altitude 30° and the latitude 37° S. Hence it appears by changing the altitude from 20° to 30°, the correction changes from 68″.2 to 75″.9, increasing 7″.7, by an increase of 10° in the altitude, the corresponding increase for a change of 8° in the altitude is equal to $7''.7 \times \frac{8}{10} = 6''.2$ nearly. This added to 68″.2 gives 74″.4, for the tabular number corresponding to the declination 6°, the altitude 28°, and the latitude 37° S. If the same calculation be repeated, using the declination 8°, the tabular number will be 76″.2 instead of 74″.4, increasing only 1″.8 for an increase of $2^\circ = 120'$ in the declination, and the corresponding correction for the 25′ of the first declination is $1''.8 \times \frac{25}{120} = 0''.4$, nearly. This added to 76″.2 gives the correct tabular number 76″.6, or 77″ nearly, corresponding to the proposed latitude, 37° S. altitude 28°, or declination 6° 25′ S. The correction for the minute of declination is in this case small, and in general it will be so, and when the change of declination during the elapsed time is only a few minutes, it will be sufficiently exact to take out, as was directed above, the numbers corresponding to the nearest declination in the table. As there is nothing peculiar in this method of finding the corrections for the intermediate degrees of altitude and latitude (several tables in the work having been arranged upon a somewhat similar plan) it will not be necessary to go into any further detail relative to the manner of finding the number from the table corresponding to any proposed declination, altitude or latitude. The use of these numbers in finding the correction of the first altitude, is, for the sake of easy reference, drawn up in the following rules.

RULE.

1. *If the two declinations are of the same name, take their difference; if they are of different names, take their sum, and this difference, or sum, will be the change of declination corresponding to the two observations, or two objects.*

2. *Find in Table* XLVIII. *the number corresponding to the first declination, the first altitude, and the latitude by account. Multiply this by the change of declination, in seconds, between the two observations; the product, rejecting the two right hand figures, will be the number of seconds to be applied to the first altitude, with the same sign as in the table,* if at the second observation, the object is nearer to the elevated pole than at the first observation; but with a different sign from the Table, if at the second observation, the object is farther from the elevated pole than at the first observation.*

Thus, in the above example, where the tabular correction was 77″, if the second altitude was 48° and the second declination 6° 15′ S. which is 10′ or 600″ less than the *first* declination 6° 25′ S. the product of 600″ by 77 (rejecting the two right hand figures) is 462″ = 7′ 42″, being the correction to be added to the first altitude 28°, making it 28° 7′ 42″, because the second declination is nearest to the elevated pole. If the second declination had been 6° 35′ S. instead of 6° 15′ S. the correction 7′ 42″ would be subtractive, making it 27° 52′ 18″.

It may be observed, that the method of correcting one of the altitudes *does not alter the horary angles in any way whatever*, and the regulation of the watch used in the observation is calculated in exactly the same manner as if the correction had not been made, and whichever altitude is corrected, the result will be very nearly the same; a difference of a few seconds will sometimes be found, owing to the small quantities neglected.

To illustrate this, the following examples are given.

EXAMPLE I.

The sun's correct central altitude was 32° 25′, his declination 17° N. Eight hours afterwards, by a watch, his correct central altitude was 30° 8′ and declination 16° 55′ N. Required the latitude, supposing the latitude by account 53° 20′ N?

The tabular correction corresponding to the first altitude 32° 25′, declination 17° N. and latitude by account 53° 20′ N. is 80″. Multiplying this by the difference of the de-

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* The signs in the Table are positive except in a few places between the tropics. In all cases without the tropics, when the distance from the elevated pole *decreases*, the altitude is to be *increased*, and when the polar distance *increases*, the altitude is to be *decreased*. The contrary takes place in those latitudes between the tropics where the tabular numbers have the sign — prefixed. It may also be observed, that the tabular number, corresponding to any possible situation of the object, cannot exceed 100″; it was however found convenient to insert a few numbers exceeding 100″, for the purpose of finding more accurately the proportional parts for the intermediate degrees of altitude or latitude corresponding to possible cases.

clination 17° — 16° 55″ = 5′ = 300″, the product (rejecting the two right hand figures) is 240″. 00 = 4′, the correction of altitude. This is to be subtracted from 32° 25′ because the sun recedes from the elevated pole, while the declination changes from 17° N. to 16° 55′ N. therefore the corrected *first* altitude is 32° 21′. Using this with the second altitude 30° 8′ the second declination 16° 55′, and the elapsed time 8 hours, the calculation may be thus made by the *first method*, as follows—

			Col. 1.		Col. 2.			Col. 3.		
Elapsed time	8h.	[P. M.]	co-sec.	10.06247						
Declination	16° 55′	N.	sec.	10.01921	. . . . . .			. . . .	co-sec.	10.53614
A			co-sec.	10.08168	co-sine	9.74812			co-sine	9.74812
½ Sum Alt's.	31	14½	co-sine	9.93196	co-sec.	10.28512	B	31° 18′ N.	co-sec.	10.28426
½ Diff. Alt's.	1	6½	sine	8.28650	sec.	10.00008		[B less than 90° named	as decl.]	
C	1	9	sine	8.30014	co-sine	9.99991			co-sine	9.99991
[Z less than 90° named as bearing of zenith.]					Z sec.	10.03325	Z	22 8 N.		
							E	53 26 N.	sine	9.90480
							Latitude	53 25 N.	sine	9.90471

As it is entirely arbitrary which altitude is considered as the *first*, or the one to be corrected, it may not be amiss to repeat the operation, considering 30° 8′ as the *first* altitude, and 16° 55′ as the *first* declination. The tabular number corresponding to these quantities, and the latitude by account is 79″ which multiplied by the change of declination 300″ (rejecting the two right hand figures) is 237″ = 3′ 57″ or 4′ nearly. This is to be added to 30° 8′ to give the corrected *first* altitude 30° 12′, because the Sun *approaches* the elevated pole, while his declination changes from 16° 55′ to 17°. Assuming, therefore, the corrected *first* altitude as 30° 12′, the *second* altitude 32° 25′, the *second* declination corresponding thereto 17° N. and the elapsed time, as before, 8 hours, the calculation may be then made as follows—

			Col. 1.		Col. 2.			Col. 3.		
Elapsed time	8h.	[P. M.]	co-sec.	10.06247						
Declination	17°	N.	sec.	10.01940	. . . . .			. . . .	co-sec.	10.53406
A			co-sec.	10.08187	co-sine	9.74850			co-sine	9.74850
½ Sum Alt's.	81°	18½	co-sine	9.93165	co-sec.	10.28429	B	31° 27′ N.	co-sec.	10.28256
½ Diff. Alt's.	1	6½	sine	8.28650	sec.	10.00008		[B less than 90° named	as decl.]	
C	1	9	sine	8.30002	co-sine	9.99991			co-sine	9.99991
[Z less than 90° like bearing of zenith.]					sec.	10.03278	Z	21 59 N.		
					Latitude		E	53 26 N.	sine	9.90480
								53 25 N.	sine	9.90471

So that the latitude is exactly the same by both methods.

If the middle time between the two observations was required, it would be obtained by adding the log. tangent of C 8.30263 to the log. secant of E 10.22493, whose sum, rejecting 10 in the index, is 8.52762 which sought for in the log. tangents correspond in the Col. P. M. to 0h. 15m. 26s. whose half 0h. 7m. 43s. is the middle time between the two observations. Taking the sum and difference of this and half the elapsed time, 4h. gives the times from noon when the observations were made, 4h. 7m. 43s. and 3h. 52m. 17s. the one being before noon, the other afternoon. The same result is obtained which ever altitude is corrected.

EXAMPLE II. [Same as Example XIII. page 145.]

Given the moon's correct central altitude 55° 20′, the moon's declination 0° 36′ N. The sun's correct central altitude at the same time 37° 40′, his declination 0° 17′ S. The *hour angle*, or difference of the right ascensions of the sun and moon 5 hours. Required the true latitude, the latitude by account being 23° 20′ N.

The tabular correction corresponding to the latitude by account 23° 20′ N. the sun's altitude 37° 40′, considered as the *first* altitude, and declination 0° 17′ S. is 50″, and the change of the two declinations from 0° 17′ S. to 0° 36′ N. is (53′ =) 3180″, this multiplied by 50, and the two right hand figures rejected, gives the correction of altitude 1590″=26′ 30″, this is to be added to the altitude 37° 40′ because the change from 0° 17′ S. to 0° 36′ N. approaches the sun to the elevated pole, therefore the sun's corrected

altitude is 38° 6′ 30″ or simply 38° 6′. Using this with the moon's altitude 55° 20′, the moon's declination 0° 36′ N. and the hour angle 5 hours, the latitude may be found by the *first method*, in the following manner :

		Col. 1.		Col. 2.		Col. 3.		
Elapsed time	5h.	co-sec.	10.21555					
Declination	0° 36′ N.	sec.	10.00002				co-sec.	11.97998
A		co-sec.	10.21557	co-sine	9.89947		co-sine	9.89947
½ Sum Alt's.	46 43	co-sine	9.83608	co-sec.	10.13789	B 0° 45′½ N.	co-sec.	11.87947
½ Diff. Alt's.	8 37	sine	9.17558	sec.	10.00493			
C		sine	9.22723	co-sine	9.99372		co-sine	9.99372
				Z sec.	10.03601	Z 23 0½ N.		
						E 23 46 N.	sine	9.60532
					Latitude	23° 24′ N.	sine	9.59904

This agrees with the calculation by the third method.

If the moon's altitude 55° 20′ had been considered as the *first* altitude and corrected, the tabular number corresponding to this altitude, the moon's declination 0° 36′ N. and the latitude by account 23° 20′ N. will be 70″. Multiplying this by the change of declination 3180″, and neglecting the two right hand figures, gives the correction of altitude 2226 = 37′ 6″ or simply 37′, which is to be subtracted from the moon's altitude 55° 20′ to obtain the corrected altitude 54° 43′, because the change from 0° 36′ N. to 0° 17′ S. makes the moon recede from the elevated pole. Using the corrected altitude 54° 43′ the sun's declination 0° 17′ S. and the sun's altitude 37° 40′ with the hour angle 5h. the latitude may be found by the *first method*, in the following manner :

		Col. 1.		Col. 2.		Col. 3.		
Elapsed time	5 h.	co-sec.	10.21555					
Declination	0° 17′ S.	sec.	10.00001				co-sec.	12.30583
A		co-sec.	10.21556	co-sine	9.89947		co-sine	9.89947
½ Sum Alt's.	46 11½*	co-sine	9.84026	co-sec.	10.14167	B 0° 21′½ S.	co-sec.	12.20530
½ Diff. Alt's.	8 31½	sine	9.17097	sec.	10.00482			
C		sine	9.22679	co-sine	9.99374		co-sine	9.99374
				Z sec.	10.03970	Z 24 7½ N.		
						F 23 46 N.	sine	9.60532
					Latitude	23° 24′ N.	sine	9.59906

Which agrees with the preceding calculations.

EXAMPLES FOR EXERCISE.

1. The sun's correct central altitude was 41° 33′ 12″, his declination 14° N. After an interval of 1h. 30m. his correct central altitude was 50° 1′ 12″ and declination 13° 58′ 38″. Latitude by account 52° 5′ N. Required the true latitude ?

The tabular number corresponding to the altitude 41° 33′ 12″ is 87″ and this being taken for the first altitude, is also corrected 41° 32′ 0″, the second altitude 50° 1′ 12″, elapsed time 1h. 30m. and declination 13° 58′ 38″ N. These make the latitude 52° 5′ N.

Or, by taking 50° 1′ 12″ for the first altitude, and using the corresponding declination, the tabular number is 95″, the corrected *first* altitude becomes 50° 2′ 30″, using this with the *second* altitude 41° 33′ 12″ the declination 14° N. and the elapsed time 1h. 30. The latitude becomes as before 52° 5′ N.

2. Given the correct central altitude of the moon 53° 43′, her declination 14° 16′ N. After an interval in which the hour angle was 1h. 44m. 15s. her correct central altitude was 42° 29′ and declination 13° 52′ N. The latitude by account 48° 54′ N. Required the true latitude ?

With the first altitude and first declination the tabular number is 98″, and the corrected first altitude 53° 19′ 28″, the second altitude 42° 29′ with which and the declination 13° 52′ N. and the corrected elapsed time or hour angle 1h. 44m. 15s. the latitude will be found 48° 55′ N.

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* In taking the half sum and half difference of the altitudes, it will be convenient to prove the accuracy of the calculation by adding this half sum to the half difference, for the sum will be the greater altitude. The difference of the same numbers will be the least altitude. Thus in the present example 46° 11′½ + 8° 31′½ = 54° 43′ the greater altitude, and 46° 11′½ − 8° 31′½ = 37° 40′ the least altitude.

Or, by taking 42° 29′ for the first altitude, and 13° 52′ N. for the first declination, the tabular correction will be 83″, the corrected *first* altitude 42° 49′, using this and the *second* altitude 53° 43′, the corresponding second declination 14° 16′ N. and the hour angle 1h. 44m. 15s. the latitude will be found 48° 54′ N. nearly agreeing with the former calculation.

3. Given the correct central altitude of the moon 55° 38′, her declination 0° 20′ S. After an interval in which the hour angle was 5h. 30m. 49s. her correct central altitude was 29° 57′, and her declination 1° 10′ N. The latitude by account 23° 25′ S. Required the true latitude ?

With the *first* altitude 55° 38′ and the *first* declination 0° 20′ S. the tabular correction is 71″ and the *first* corrected altitude 54° 34′ 6″. Using this with the second altitude 29° 57′, the second declination 1° 10′ N. and the hour angle 5h. 30m. 49s. the true atitude will be found 23° 23′ S.

Or, by taking 29° 57′ for the *first* altitude, and 1° 10′ N. for the *first* declination, the tabular correction will be 45″ and the first corrected altitude 30° 37′. Using this with the *second* altitude 55° 38′ the second declination 0° 20′ S. and the hour angle 5h. 30m. 49s. the true latitude will be found to be 23° 24′ S. nearly agreeing with the preceding calculations.

In making the calculations of these three examples the seconds were noticed, which is always best to be done, particularly when the altitudes are nearly equal; some difference might be found in the above results if the nearest minutes only were taken. Thus, Example XII. page 144, calculating to the nearest minute, only gives the latitude 53° 28′. If the calculation be made as in Ex. I. of this appendix, it becomes 53° 25′, differing 3′. This would be avoided by taking the angles to seconds, and in some extreme case it would require the use of 6 or 7 places of decimals.

TABLE XLVIII.

TABLE shewing the variation of the altitude of an object arising from a change of 100 seconds in the declination. If the change moves the body towards the elevated pole, apply the correction to the altitude with the signs in the Table; otherwise, change the signs.

Dec.	Alt.	LATITUDE *Of same name as declination.*								LATITUDE *Of different name from declination.*							Alt.	Dec.
		70°	60°	50°	10°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°		
0°	0"	94"	87"	76"	64"	50"	34"	17"	0"	17"	34"	50"	64"	76"	87"	94	0"	0°
	10	95	88	78	65	51	35	18	0"	18	35	51	65	78	88	95	10	
	20	100	92	82	68	53	36	18	0"	18	36	53	68	82	92	100	20	
	30		100	88	74	57	39	20	0"	20	39	57	74	88	100		30	
	40			100	84	65	45	22	0"	23	45	65	84	100			40	
	50				100	78	53	27	0"	27	53	78	100				50	
	60					100	68	35	0"	35	68	100					60	
	70						100	51	0"	51	100						70	
2°	0	94	87	77	64	50	34	17	0	17	34	50	64	77	87	94	0	2°
	10	95	87	77	65	50	34	17	—1	18	35	51	66	78	88	96	10	
	20	99	91	81	67	52	35	17	—1	19	37	54	69	83	93	101	20	
	30	107	98	87	73	56	38	18	—2	22	41	59	76	90	102		30	
	40		111	98	82	63	42	20	—2	25	47	68	86	102			40	
	50			116	97	74	50	24	—3	30	57	81	103				50	
	60				124	95	64	30	—5	40	73	105					60	
	70					139	92	43	—8	59	108						70	
4°	0	94	87	77	64	50	34	17	0	17	34	50	64	77	87	94	0	4°
	10	94	87	77	64	50	34	16	—1	19	36	52	67	79	89	97	10	
	20	98	90	79	66	51	34	16	—3	21	39	56	71	84	95	103	20	
	30	105	96	85	70	54	36	16	—4	24	44	62	78	93	104		30	
	40		107	94	78	59	39	17	—6	29	51	71	90	106			40	
	50			111	92	70	45	19	—8	35	62	86	109				50	
	60				117	88	56	23	—12	47	81	112					60	
	70					127	81	32	—19	70	119						70	
6°	0	94	87	77	65	50	34	17	—0	17	34	50	65	77	87	94	0	6°
	10	94	87	76	64	49	33	16	—2	20	37	53	67	80	90	98	10	
	20	97	89	78	65	50	33	15	—4	22	40	57	73	86	96	104	20	
	30	103	94	83	69	52	34	14	—6	26	46	64	81	95	107		30	
	40		105	92	76	57	36	14	—9	32	54	74	93	109			40	
	50			107	88	66	41	15	—13	40	66	91	113				50	
	60				111	82	51	17	—18	53	87	119					60	
	70					118	72	22	—29	80	129						70	
8°	0	95	87	77	65	50	35	18	—0	18	35	50	65	77	87	95	0	8°
	10	94	86	76	63	49	33	15	—3	20	38	54	68	81	91	99	10	
	20	96	88	77	64	49	32	14	—5	24	40	59	74	87	98	106	20	
	30	101	93	81	67	50	32	12	—8	28	48	66	83	97	109		30	
	40		102	89	73	54	33	11	—12	35	57	78	97	113			40	
	50			104	84	62	37	11	—17	44	70	95	118				50	
	60				105	77	45	11	—24	59	93	125					60	
	70					109	62	13	—39	90	140						70	
10°	0	95	88	78	65	51	35	18	—0	18	35	51	65	78	88	95	0	10°
	10	94	86	75	63	48	32	15	—3	21	38	55	69	82	92	100	10	
	20	95	87	76	63	48	31	12	—6	25	43	60	76	89	100		20	
	30	100	91	80	65	49	30	10	—10	30	50	69	86	100			30	
	40		100	87	70	51	31	8	—15	38	60	81	100				40	
	50			100	81	58	33	6	—21	48	75	100					50	
	60				100	71	39	5	—31	66	100						60	
	70					100	53	3	—48	100							70	
12°	0	96	89	78	66	51	35	18	—0	18	35	51	66	78	89	96	0	12°
	10	94	86	76	63	48	32	14	—4	22	39	56	70	83	94	101	10	
	20	94	86	76	62	47	29	11	—8	27	45	62	78	91	102		20	
	30	99	90	78	64	47	28	8	—12	33	53	71	88	103			30	
	40	108	98	84	68	49	28	5	—18	41	63	85	104				40	
	50		112	97	77	54	29	2	—25	53	80	105					50	
	60			120	95	65	33	—1	—37	72	107						60	
	70				134	91	44	—6	—58	110							70	
Dec.	Alt.	70°	60°	50°	10°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°	70°	Alt.	Dec.
		LATITUDE *Of same name as declination.*								LATITUDE *Of different name from declination.*								

TABLE XLVIII.

TABLE shewing the variation of the altitude of an object arising from a change of 100 seconds in th[...] this change moves the body towards the elevated pole, apply the correction to the altitude with the si[...] otherwise, change the signs.

		LATITUDE *Of same name as declination.*								LATITUDE *Of different name from declination.*					
Dec.	Alt.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°
	0°	97″	89″	79″	66″	52″	35″	18″	0	18″	35″	52″	66″	79″	89″
	10	94	86	76	63	48	31	14	—4	23	40	57	72	85	95
	20	94	86	75	61	46	27	10	—9	28	45	64	80	93	104
	30	97	89	77	62	45	26	6	—14	35	55	74	91	106	
14°	40	106	96	82	66	46	25	2	—21	44	67	88	107		
	50		109	93	73	50	25	—2	—30	58	85	110			
	60			115	89	60	27	—7	—43	79	114				
	70				125	82	35	—16	—69	121					
	0	98	90	80	67	52	36	18	—0	18	36	52	67	80	90
	10	94	86	76	63	48	31	13	—5	23	41	58	73	86	97
	20	94	85	74	61	45	27	9	—10	30	48	66	82	95	106
	30	96	87	75	61	44	25	4	—17	37	58	77	94	109	
16°	40	104	94	80	63	44	22	0	—24	48	70	93	111		
	50		106	90	70	47	21	—6	—34	62	90	115			
	60			110	84	54	21	—14	—50	86	121				
	70				117	73	25	—26	—79	132					
	0	99	91	81	68	53	36	18	—0	18	36	53	68	81	91
	10	95	87	76	63	48	31	13	—6	24	42	59	74	88	98
	20	93	85	74	60	44	26	8	—12	31	50	68	84	98	109
	30	95	86	74	59	42	23	2	—19	40	60	79	97	112	
18°	40	102	92	78	61	41	20	—3	—27	51	74	96	116		
	50		103	87	66	43	17	—10	—39	67	95	121			
	60			105	79	49	16	—20	—56	93	128				
	70				108	64	16	—36	—89	143					
	0	100	92	82	68	53	36	18	—0	18	36	53	68	82	92
	10	95	87	76	63	48	31	12	—6	25	43	60	76	89	100
	20	93	85	74	60	43	25	6	—13	33	52	70	86	100	
	30	94	85	73	58	40	21	0	—21	42	63	82	100		
20°	40	100	90	76	59	39	17	—6	—31	55	78	100			
	50		100	83	63	39	13	—15	—43	72	100				
	60			100	74	43	10	—26	—63	100					
	70				100	56	6	—46	—100						
	0		93	83	69	54	37	19	—0	19	37	54	69	83	93
	10	96	88	77	63	48	30	12	—7	26	45	62	78	91	102
	20	93	85	73	59	43	25	5	—15	35	54	72	88	103	
	30	94	85	72	57	39	19	—2	—23	45	66	86	103		
22°	40	98	88	74	57	36	14	—9	—34	58	82	104			
	50	110	97	80	60	36	9	—19	—48	77	106				
	60		117	95	68	38	4	—33	—70	107					
	70			131	92	47	—3	—56	—111						
	0		95	84	70	55	37	19	—0	19	37	55	70	84	95
	10	97	88	77	64	48	30	11	—8	27	46	63	79	93	104
	20	93	85	73	59	42	24	4	—16	36	56	74	91	105	
	30	93	84	71	56	38	18	—4	—26	48	69	89	107		
24°	40	97	86	72	54	34	12	—12	—37	62	86	109			
	50	107	93	77	56	32	5	—23	—53	83	111				
	60		112	91	64	32	—2	—39	—77	115					
	70			123	83	38	—13	—67	—122						
	0		96	85	72	56	38	19	—0	19	38	56	72	85	96
	10	98	89	78	64	48	30	11	—9	28	47	65	81	95	106
	20	95	85	73	59	41	23	3	—18	38	58	77	94	108	
	30	93	83	70	54	36	16	—6	—28	50	72	92	111		
26°	40	96	85	70	52	32	9	—16	—41	66	91	114			
	50	105	92	74	53	28	1	—28	—58	88	117				
	60		108	86	58	27	—8	—46	—84	123					
	70			115	75	29	—23	—78	—134						
Dec.	Alt.	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60°
		LATITUDE *Of same name as declination.*								LATITUDE *Of different name from declinatio[...]*					

New Form of Table XX. for working a Lunar Observation.

SINCE the former part of this work was printed, a new form has been given to Table XX. by which the last corrections of a Lunar Observation may be found very expeditiously. The correction in this new Table will frequently exceed those deduced from the former one by two or three seconds, on account of having introduced the fourth and fifth corrections, which were formerly omitted.

In using this new Table, it will in general be sufficiently accurate to find the nearest altitudes and distance, and take out the corresponding correction, without the trouble of making a proportion for the neglected degrees and minutes. Thus in Example I. enter the new table with the ✱'s altitude 50°, ☽'s altitude 70°, distance 50°, which are the nearest numbers in the Table, the corresponding correction is 20″, as found before. In the second example the ✱'s altitude 10°, ☽'s 20°, distance 60°, give the correction 27″, being 4″ more than the former method. In the third example the correction is 24″. In the fourth 22″. In the fifth 17″. In the sixth 19″. These corrections are always additive.

In using the second and third methods of working a lunar observation, this correction is to be found in the same manner, and added to the corrected distance, subtracting 18″ from the sum. Thus, in Example I. the correction 20″ is to be added, and the constant quantity 18″ subtracted, leaving 2″ to be added instead of 1″, found by the former method.

TABLE XX. (*New Form.*) Correction in Seconds, *additive*.

True distance of the Moon from the Sun or a Star.

☉✱ Alt.	☽ Alt.	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°	90°	100°	110°	120°	☽ Alt.	☉✱ Alt.
10°	10°	96″	79″	67″	60″	53″	48″	41″	37″	31″	27″	23″	19″	15″	11″	10°	10°
	20	66	71	64	58	52	48	43	37	31	27	22	18	15	11	20	
	30	18	39	46	46	44	42	39	34	30	25	22	18	15	13	30	
	40			18	28	32	33	33	30	27	24	21	18	16	15	40	
	50					18	25	25	26	24	22	20	18	17	18	50	
	60							18	22	22	21	19	18	18		60	
	70								18	19	19	18	18			70	
	80									18	18	18				80	
20°	10°	60	64	58	51	46	42	39	33	28	24	20	17	13	10	10°	20°
	20	89	75	63	56	49	44	40	33	28	24	20	17	14	11	20	
	30	67	62	58	50	45	41	38	32	27	23	20	17	15	14	30	
	40	18	35	39	39	38	36	33	29	25	22	19	17	16	18	40	
	50			18	25	28	29	28	26	23	21	19	18	18		50	
	60					18	21	23	23	21	20	18	18			60	
	70							18	20	20	19	18				70	
	80								18	18	18					80	
30°	10°	18	35	40	40	38	36	34	30	26	22	19	16	14	12	10°	30°
	20	66	60	53	49	44	40	36	31	26	22	19	16	15	14	20	
	30	78	64	55	48	43	39	36	30	25	22	19	17	16	18	30	
	40	57	53	48	43	38	36	33	28	24	21	19	17	18		40	
	50	18	31	34	34	32	30	29	25	22	20	18	18			50	
	60			18	23	25	25	24	22	20	19	18				60	
	70					18	20	21	20	19	18					70	
	80							18	19	18						80	
40°	10°			18	26	28	29	29	27	24	21	19	17	15	15	10°	40°
	20	18	34	38	38	36	34	32	28	24	21	19	17	16	18	20	
	30	58	32	47	42	38	35	32	27	24	21	18	17	18		30	
	40	64	54	46	41	37	33	30	26	22	20	18	18			40	
	50	47	43	39	35	32	30	27	24	21	19	18				50	
	60	18	27	28	28	27	25	24	21	19	18					60	
	70			18	21	22	21	21	19	18						70	
	80					18	19	19	18							80	
50°	10°					18	22	23	23	22	20	18	17	17	18	10°	50°
	20			18	25	27	27	27	25	22	20	18	18	18		20	
	30	18	30	33	33	32	30	28	25	22	20	18	18			30	
	40	48	43	39	35	32	30	27	24	21	19	18				40	
	50	50	42	37	33	30	27	25	22	19	18					50	
	60	36	34	31	28	28	24	22	20	18						60	
	70	18	23	23	23	22	21	20	18							70	
	80			18	19	19	19	18								80	
60°	10°							18	20	20	19	18	18	18		10°	60°
	20					18	21	22	22	21	19	18	18			20	
	30			18	23	24	24	24	22	20	19	18				30	
	40	18	26	28	28	27	26	24	21	19	18					40	
	50	36	33	31	28	26	24	22	20	18						50	
	60	36	31	28	25	23	22	20	18							60	
	70	27	25	23	22	20	19	18								70	
	80	18	20	19	19	18										80	
70°	10°								18	19	19	18	18			10°	70°
	20							18	20	19	18	18				20	
	30					18	20	20	20	19	18					30	
	40			18	21	22	21	21	19	18						40	
	50	18	23	23	23	22	21	20	18							50	
	60	27	25	23	22	20	19	18								60	
	70	25	23	21	19	18										70	
	80	20	19	18												80	
80°	10°									18	18	18				10°	80°
	20								18	18	18					20	
	30							18	19	18						30	
	40					18	19	19	18							40	
	50			18	19	19	19	18								50	
	60	18	20	19	19	18										60	
	70	20	19	18												70	
	80	18														80	

END OF THE APPENDIX.

EDMUND HAVILAND,

IMPORTER OF

CHINA, GLASS AND EARTHENWARE,

HAS constantly on hand an extensive assortment of FINE CUT and PLAIN GLASS, CHINA and EARTHENWARE, at the lowest prices, by the package or less quantity, at his store

No. 306 *Pearl-street, just below Peck-slip, New-York.*

N. B. The most approved articles and patterns for ship's use. May, 1826.

CABINET WAREHOUSE,

No. 48 *Canal-street,*

HENRY M. BRITON, informs the public that he has constantly on hand, an extensive assortment of Furniture, of every description in his line, together with Mahogany Chairs of the first style ; all of which he will dispose of on the most reasonable terms. A share of the public patronage is solicited. New-York, May, 1826.

S. HUTCHINSON,

CABINET MAKER,

No. 98 *Canal-street*, NEW-YORK.

☞Sideboards, Secretaries, Sofas, Dining, Breakfast and Card Tables, &c. &c. of the newest fashions, and made of the best materials, constantly for sale—or made to order, on the most accommodating terms. May, 1826.

PIANO FORTES.

T. LOUD,—PIANO FORTE MAKER, (from London,) respectfully informs the public that he has replenished his stock, and has for sale a handsome assortment of very superior Piano-Fortes of *touch* and *tone*, seldom to be equalled ; one of which, just finished, with four pedals, is of unusual and unrivaled splendour, united with real excellence. Merchants visiting the city, would consult the interest of themselves and friends, (from whom they may have brought orders) by examining the above. Prices moderate, and all Pianos warranted. Pianos tuned and repaired, and old ones taken in exchange. No. 102 Canal-street, (between Broadway and Lafayette Circus.)

April, 1826.

FIRTH & HALL,

Musical Instrument Makers, and Importers of

ALL KINDS OF MUSICAL MERCHANDISE,

No. 358 *Pearl-street, near Franklin-square,*

NEW-YORK,

Have constantly for sale an assortment of Piano Fortes, and Musical Instruments of the most celebrated Makers and of their own manufacture ; together with every other article of Musical Merchandise, wholesale and retail, on the most liberal terms. BANDS supplied with Instruments, &c. Musical Instuments of all kinds tuned and repaired in the neatest manner. All orders thankfully received and attended to with care and despatch. April, 1826.

N. KNIGHT,

BOOK, STATIONARY, AND VARIETY STORE,

Thames-street, late Fell-street, Fell's Point,

April, 1826. BALTIMORE.